GENERATION, TRANSMISSION AND APPLICATION OF THE POWER SERVICES

Power

A McGRAW-HILL PUBLICATION

July 1954·50¢

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Paid circulation this issue: over 45,000

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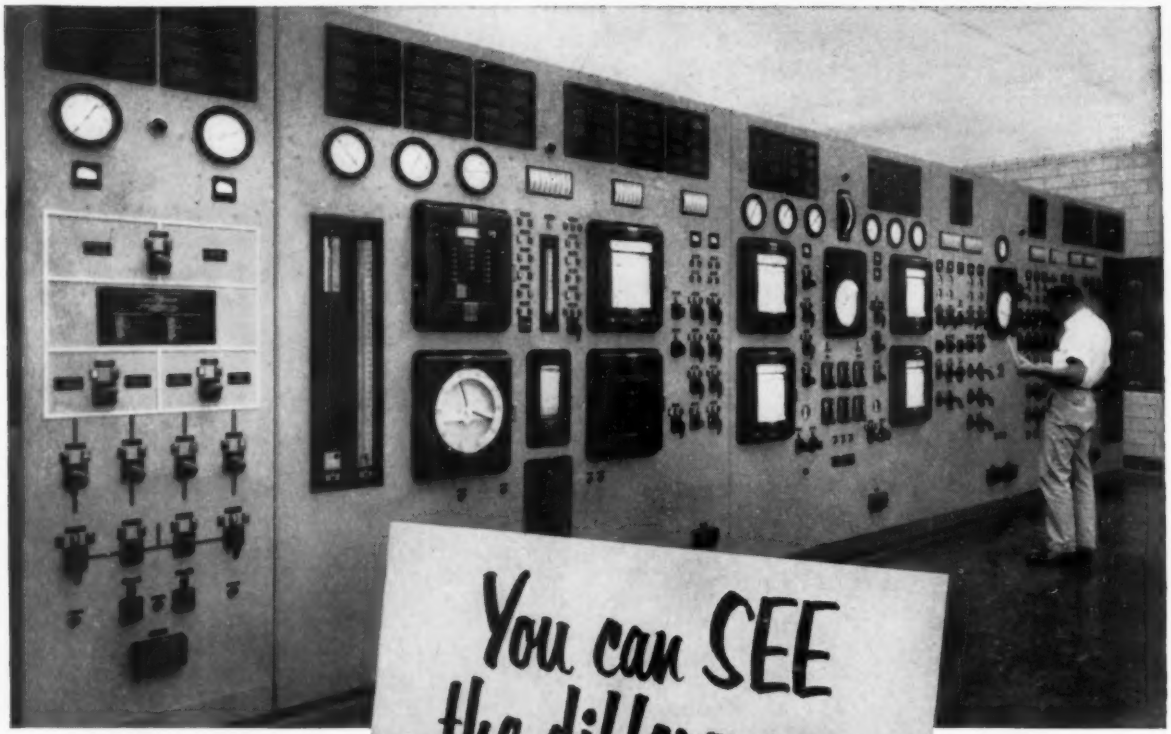

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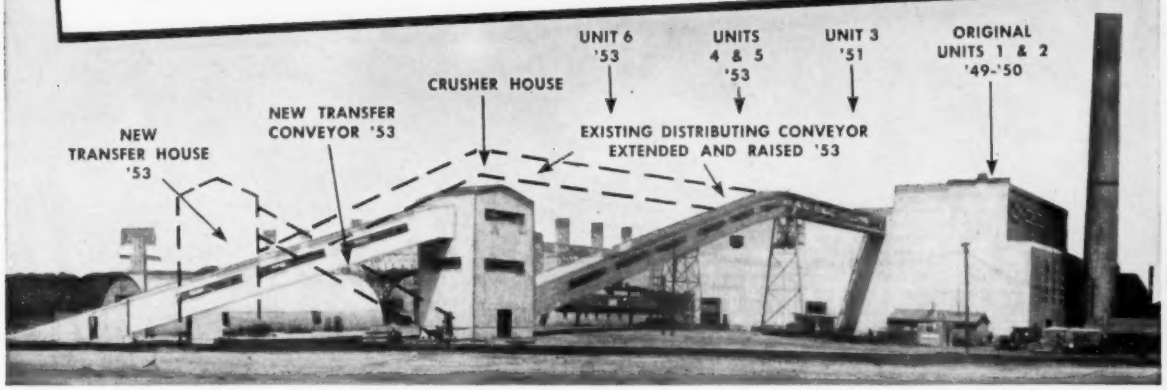

Dotted lines show additions since 1950 to original White River station of Indianapolis Power & Light. Two units were added without change in the coal handling system. However, a fifth unit was built in 1953, requiring the above change in the system. Provision was made at this time for a future sixth unit.

For the fourth time in recent years, Indianapolis Power & Light relies on Link-Belt coal handling equipment and experience

PROOF of the versatility of Link-Belt engineering is the White River station of Indianapolis Power & Light. Not only did the initial plans provide for future expansion, but when loads exceeded the forecast, Link-Belt—working with IPL's consultants, Gibbs & Hill—designed a low-cost revamp of the coal handling system that can fuel two additional generating units.

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Link-Belt can offer all types and sizes of equipment for unloading, storing, reclaiming, conveying, elevating and feeding your coal.

Your nearby Link-Belt sales representative will be glad to work with you and your consultants . . . help analyze your coal handling requirements. And be sure to ask him for a copy of Book 2410 that shows the latest in equipment and layouts for power plants large and small.

Distributing belt conveyor rolls on 36-in. Link-Belt roller bearing idlers. Coal is discharged to bunkers by self-propelled tripper that opens and closes bunker seals to confine dust.

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COAL HANDLING EQUIPMENT

Write for 42-page Link-Belt Power Plant Book 2410

LINK-BELT COMPANY: Executive Offices, 307 N. Michigan Ave., Chicago 1. To Serve Industry There Are Link-Belt Plants and Sales Offices in All Principal Cities. Export Office, New York 7; Canada, Scarboro (Toronto 13); Australia, Marrickville, N.S.W.; South Africa, Springs. Representatives Throughout the World.

13,513

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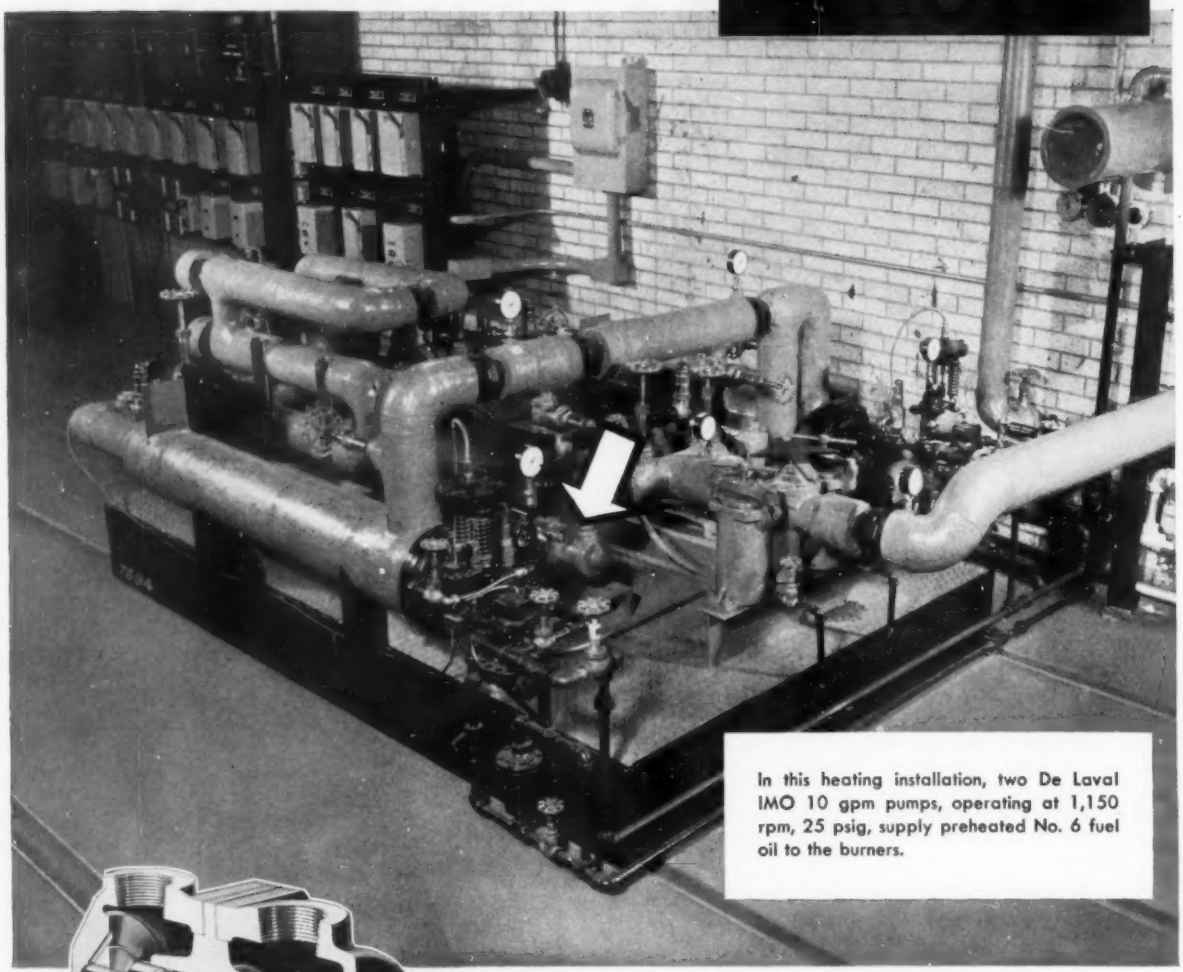
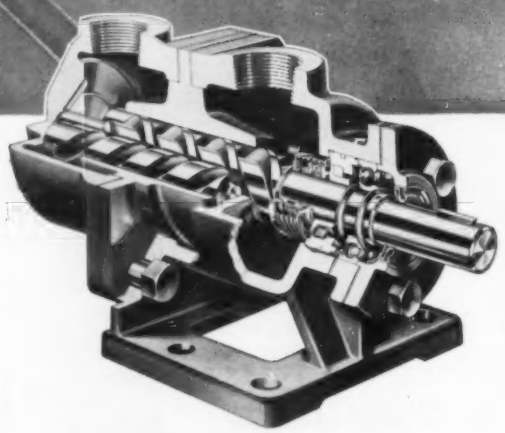
DE LAVAL
IMO PUMPS



In this heating installation, two De Laval IMO 10 gpm pumps, operating at 1,150 rpm, 25 psig, supply preheated No. 6 fuel oil to the burners.



A wide range of De Laval IMO models specifically built for fuel oil service is available. Capacities up to 80 gpm, pressures to 275 psig. Write today for Bulletin LG-A.

To increase your present—and future—profits on commercial heating jobs, install *dependable* De Laval IMO pumps on pump and heater sets. Their simple, trouble-free design saves you money on service calls . . . builds customer goodwill, for there's nothing to get out of order or need adjustment. No pilot gears, no sliding vanes, no reciprocating pistons. De Laval IMO's have only three moving parts—smoothly intermeshing rotors that propel the fluid axially in a steady flow without churning, pocketing or pulsation.

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Power

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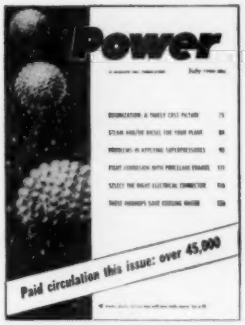


COVER DESIGN is an intangible factor in magazine publishing, with the aim of satisfying two apparently opposite goals. A cover must possess some elements of sameness each issue to help the reader quickly identify the magazine. Yet the same cover must introduce enough change to appeal to the reader each month, while serving as a key to speedy recognition of that issue.

This month's cover is in sharp contrast to many of our recent designs. We don't look upon it as a permanent change in format, but rather as simply another step in our never-ending quest for a cover design best suited for a particular issue.

Next month . . .

■ Designers of boilers, gas turbines and other combustion equipment continually seek ways of getting higher heat in a given space. One proposed way to do this is by flash or pulsating combustion rather than today's constant-pressure methods. The first of a 2-part article covers pulsating-combustion theory.

■ Interested in how one of Alcoa's smaller plants whittled electrical distribution costs to the core? Look to August for design features plus how-to info on aluminum conductors.

■ There is much confusion amongst laymen as to the possible damage resulting from an atomic- or hydrogen-bomb blast. An article by Phil Swain will give the specific radius, area and degree of damage you can expect from any size bomb. You, as a technically minded citizen, can use it to dispel some of the present wild guesses.

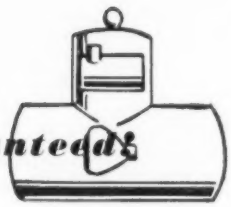
■ New units in the Delaware Station are the first reheats in the Philadelphia Electric System. One design feature: gas recirculation from economizer outlet to furnace serves as primary superheater temperature control. You'll find complete details in the August issue.

. . . and future months

■ POWER'S *Modern Plant Handbook* issue is coming up in mid-September. In it, along with many other features, is the Modern Plant Survey. Here you will find the most complete data available on plants being planned, under construction and starting operation.

DEAERATING EFFICIENCY

less than seven parts per billion guaranteed



These are words. What you want is *PERFORMANCE.* Cochrane's unparalleled experience in years and number of installations with all types of deaerating equipment assures you that *guarantees will be met!* Check this statement with any Cochrane user.

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For further information on Cochrane Deaerators, write for Publication Nos. 3005, 4643 and 4635.

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...with Power readers...

Each month POWER *surveys a different segment of its readers asking for their reactions to articles in the current issue. The reader is given an opportunity to score each article and comment on* POWER. *Here are excerpts from a recent survey:*

The material is over-simplified . . . I don't like wordy articles . . . I think the articles are well written . . . I have read POWER over 40 years. Many articles in a single issue are worth more than the subscription price. POWER's ads carry a wealth of information of great value to engineers

Fair; too much space for readers' letters and handy hints to mechanics. Not professional enough . . . POWER is the best of 15 magazines I read each month . . . Would like to see more on atomic energy, superpressures, gas turbines . . . A power engineer's bible . . . I have subscribed since 1927. It gets better each year . . . I especially like the "famous" POWER Reports . . . Advertising of new and competitive products is one of the most interesting phases since we obtain bids on various equipment and materials for construction . . . Too much small print . . . Just what the doctor ordered for plant engineers . . . Generally satisfactory. However, I like big-plant articles . . . More on smaller plants . . . I've been a continuous subscriber since 1933. This speaks for itself.

A good magazine. Stop worrying.

...lines and bylines

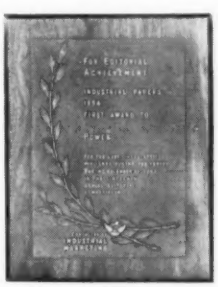
NUCLEAR PLANTS are the current concern of Henry Schwenk, coauthor of nuclear-energy study course starting on p 88 of this issue. He spent 18 months recently with Dow-Detroit Edison Nuclear Power Project, wrestling with this new arrival in the power field. In a future issue you'll meet Bob Shannon who teams up with Schwenk in writing this series.

Henry C Schwenk

After Iowa State (BS in ME '44) came a hitch in the Navy, then a spell with Midwest Piping and Supply Co. In 1949, Schwenk joined the Henry Pratt Co where he is now district sales manager. He started in the field, supervising central-station construction. Then, as Schwenk puts it, he worked on "conceptual design and development of specialized large control and sectionalizing valving for wind tunnels and ram-jet test facilities for aircraft industry."

While on loan from the Pratt Co to the Dow-Detroit Edison group, he found the only reference material on nuclear energy power plants was slanted for the physicist rather than the engineer. It was this absence of understandable theory that prompted the study course.

Now Henry is acclimating to a new and permanent house guest: a 3-months baby girl. Time permitting, he tries to break 100 in golf.



HIGHEST HONORS came again to POWER when our report, *Today's Electrical Practice* (Oct 1953), was selected by 24 of our peers from 475 entries, as the best single article published in an industrial magazine during 1953. Award was made as part of the 16th Annual Business Paper Editorial Achievement Competition, sponsored by the magazine *Industrial Marketing*. We are proud to have this report line up alongside those other POWER reports similarly recognized in past years.

Readers' letters and requests for reprints are another form of recognition regarded highly by editors. To date we have had requests for 5400 reprints of this report along with numerous letters commenting on its value in everyday practice . . . "as an extended check list of electrical techniques that are being adopted in today's well-designed industrial plants."

TOP MAN in the porcelain coating field is a term rightfully applied to William Austin Barrows. In 1933, architectural training behind him (U of Cincinnati), Barrows started his own enameling firm after fire destroyed the only other such plant in Cincinnati. Now he is president of both Porcelain Enamel Institute, and Barrows Porcelain Enamel Co.

William A Barrows

In the past five years, Bill has guided his concern through a geared-up program aimed at ferreting out new uses for glass-coated steel products in the industrial field. As outlined on p 111, porcelain enamel is well suited for bucking corrosion in boiler tubes, pump impellers and heat exchangers—a few of its many uses.

His private plane (he's a licensed pilot) helps him keep tabs on the company's growing operations. In his spare moments, carefully budgeted from a tight schedule, Bill favors his boat on Lake Erie.

B&W Cyclone Furnace

a growing factor in the

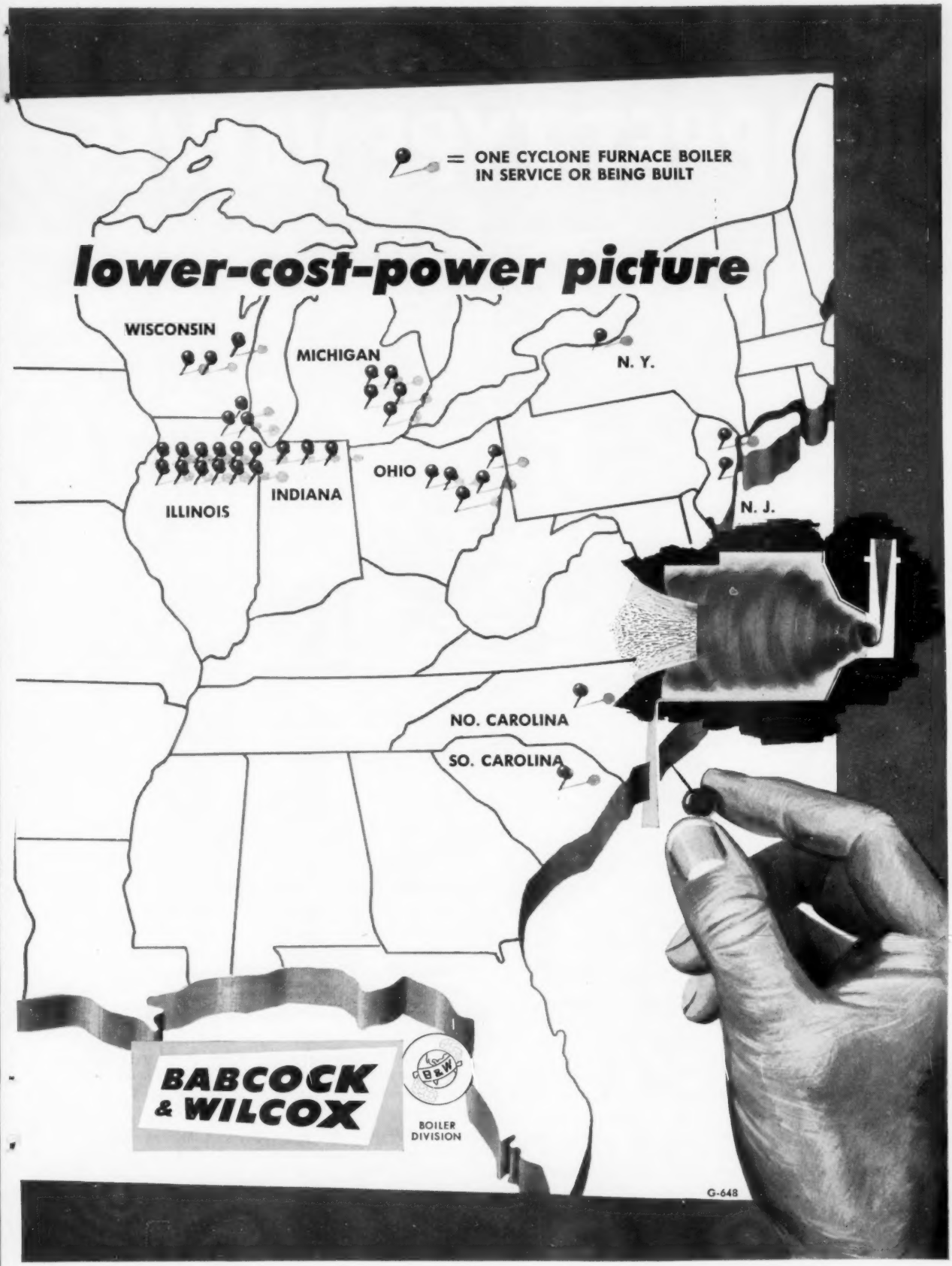
Cost-saving advantages vital to power plant operators are responsible for the mounting acceptance of the Cyclone Furnace. Each represents an important advance in the relentless search of power engineers and designers for more efficient ways to further lower the cost of generating steam for power.

The Cyclone Furnace—

- **Reduces atmospheric pollution to extremely low levels**
- **Simplifies ash handling and disposal**
- **Burns fuel with greater efficiency**
- **Provides greater fuel flexibility with attendant lower costs**
- **Reduces overall first cost**
- **Increases safety by simplifying operation**
- **Reduces maintenance**
- **Increases availability**

Originally designed and developed to burn more efficiently a wide range of coals, as well as oil and gas, the Cyclone Furnace is now being installed in areas where factors other than fuel are prime contributors to higher power generating costs. For whatever the problems — fuel, fly-ash, availability, cost, maintenance — the Cyclone Furnace contributes directly and substantially toward solving them.

With its revolutionary approach to the entire process of preparing and burning fuel, the B&W Cyclone Furnace offers such a simplification of initial design and increased facility in everyday operation, that the overall cost of producing power is greatly benefited. Let us discuss with you the various cost-saving advantages of the Cyclone Furnace for your operation. The Babcock & Wilcox Company, Boiler Division, 161 East 42nd Street, New York 17, N. Y.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lower-cost-power picture
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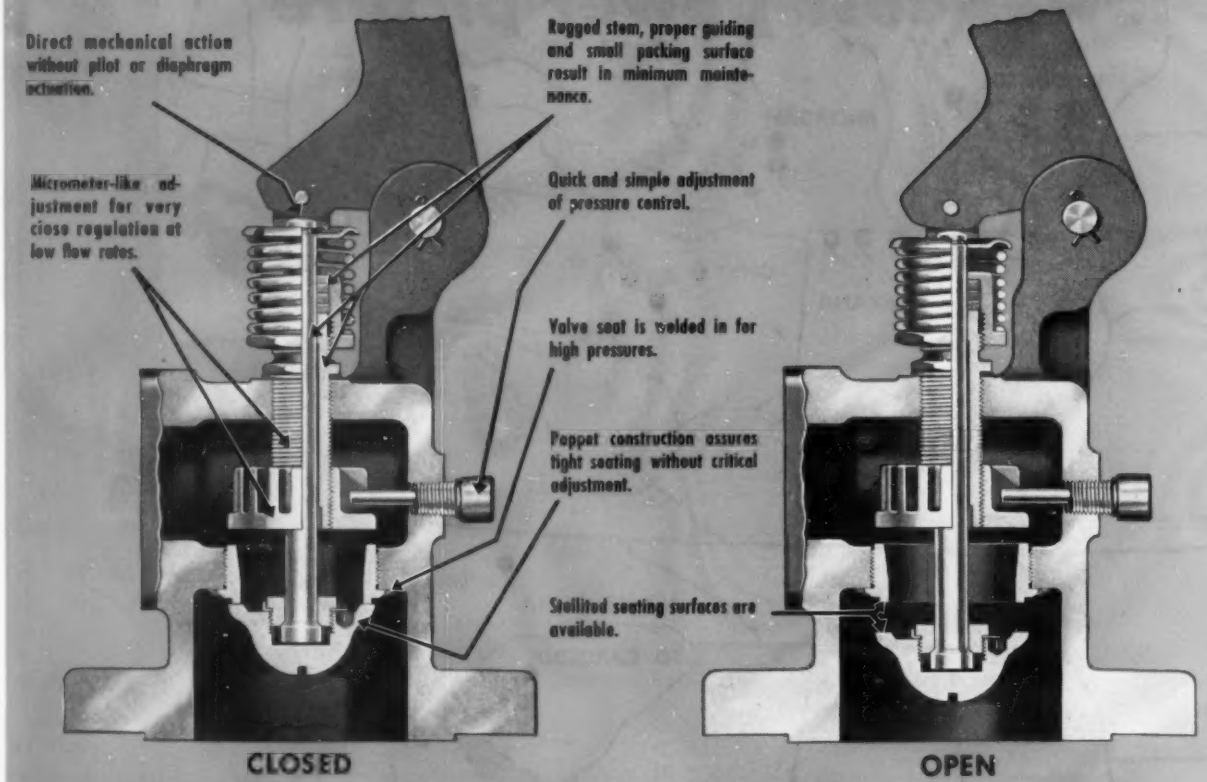
POPPET TYPE VALVES


Direct mechanical action without pilot or diaphragm actuation.
Micrometer-like adjustment for very close regulation at low flow rates.
Rugged stem, proper guiding and small packing surface result in minimum maintenance.
Quick and simple adjustment of pressure control.
Valve seat is welded in for high pressures.
Poppet construction assures tight seating without critical adjustment.
Stellited seating surfaces are available.
CLOSED
OPEN

Demands on a soot blower valve are extremely severe . . . performance requirements very high. Long experience has shown that the poppet type valve is the most satisfactory unlubricated valve for such rugged work. (It is also used in automobile engines.) The Diamond Poppet Type has proved its superiority by many years of successful operation on the most difficult jobs . . . it is an important factor in the outstanding performance of the blowers shown on the opposite page.

Construction assures tight seating without close adjustments. Valve seat is welded in for high pressure service and Stellite seating surfaces are available for conditions that require them. The valve readily lends itself to examination and repair. Disc and seat are quickly accessible, and regrinding can be done quickly without dismounting the head. Seat and disc are forged and the stem rolled from stainless steel.

The integral adjustable pressure control device is used when boiler pressure is higher than desirable for blowing . . . but not so extreme as to require a separate pressure reducing valve. It is easily and quickly adjusted . . . consists of a ribbed disc carried on the threaded valve stem guide. Its location outside the path of valve travel permits full and immediate opening of the poppet valve, thus avoiding wire drawing.

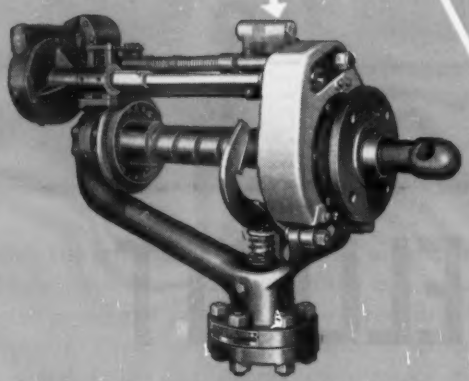
This valve construction is one of the many reasons why Diamond blowers give better boiler cleaning at lower cost.

Model IX valve shown above; Models IR and G9B valves have same advantages.

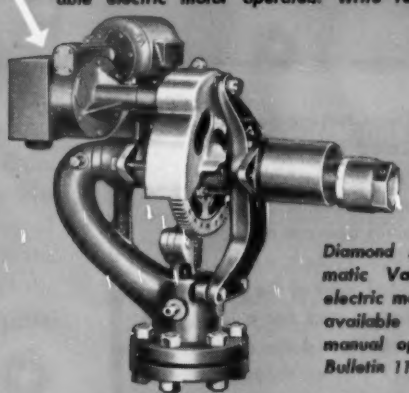
6890

An IMPORTANT REASON for the better performance of *these* DIAMOND Blowers

Diamond Model IK Long Retracting Blower with mechanically operated valve. Air motor operated unit shown; also available electric motor operated. Write for Bulletin 1080.



Diamond Model IR Short Retracting Blower with air motor operation; electric or manual operation also available. Write for Bulletin 1079.



Diamond Model G9B Automatic Valved Blower with electric motor operation; also available with air motor or manual operation. Write for Bulletin 1137U.

DIAMOND POWER SPECIALTY CORPORATION
LANCASTER, OHIO
Diamond Specialty Limited • Windsor, Ontario

Keeping pace with modern

These two Elliott turbine-generator units are located in an interesting new central station which was completed at a station cost of $139 per kw! The turbines operate on steam at 850 psi, 900°F. Both machines are base loaded, part of the power production being used for a local distribution system and the surplus sold as block power through a transmission interchange.

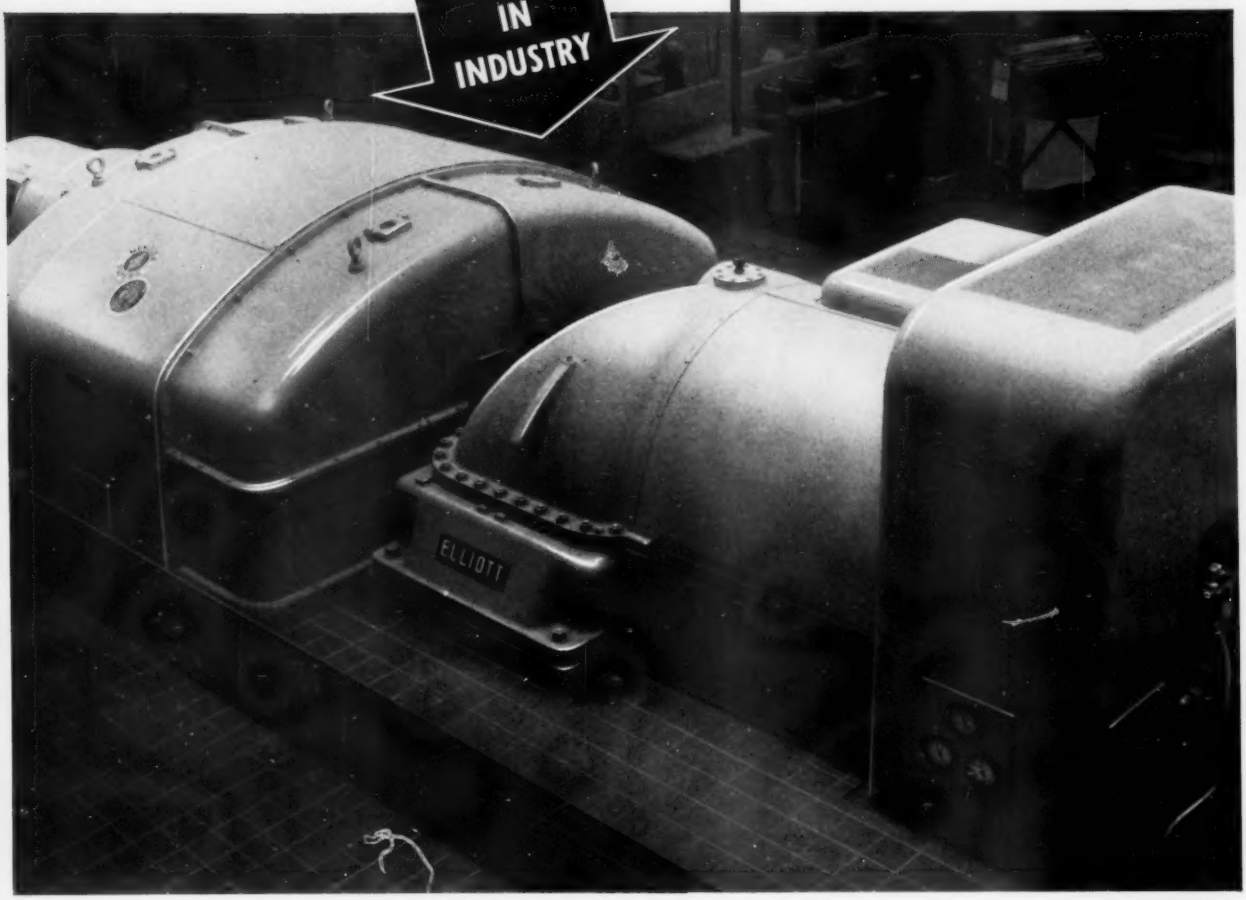
ELLIOTT TURBINE-GENERATORS

H4-5

requirements

IN INDUSTRY

This Elliott turbine-generator unit serves an industrial power plant. It extracts steam for process at 30 psig, being supplied with 400 psig, 700°F steam. This unit is an extension to an existing industrial power plant served by an Elliott back-pressure extraction unit.



ELLIOTT TURBINE-GENERATORS meet the requirements for efficient power generation in utility stations, and the balanced power and process steam requirements of industrial plants. Their modern appearance is indicative of their sound design and superior performance. Both the steam and electrical elements are made by Elliott and the result is a coordinated unit, specifically designed to the individual needs of the plant or station.

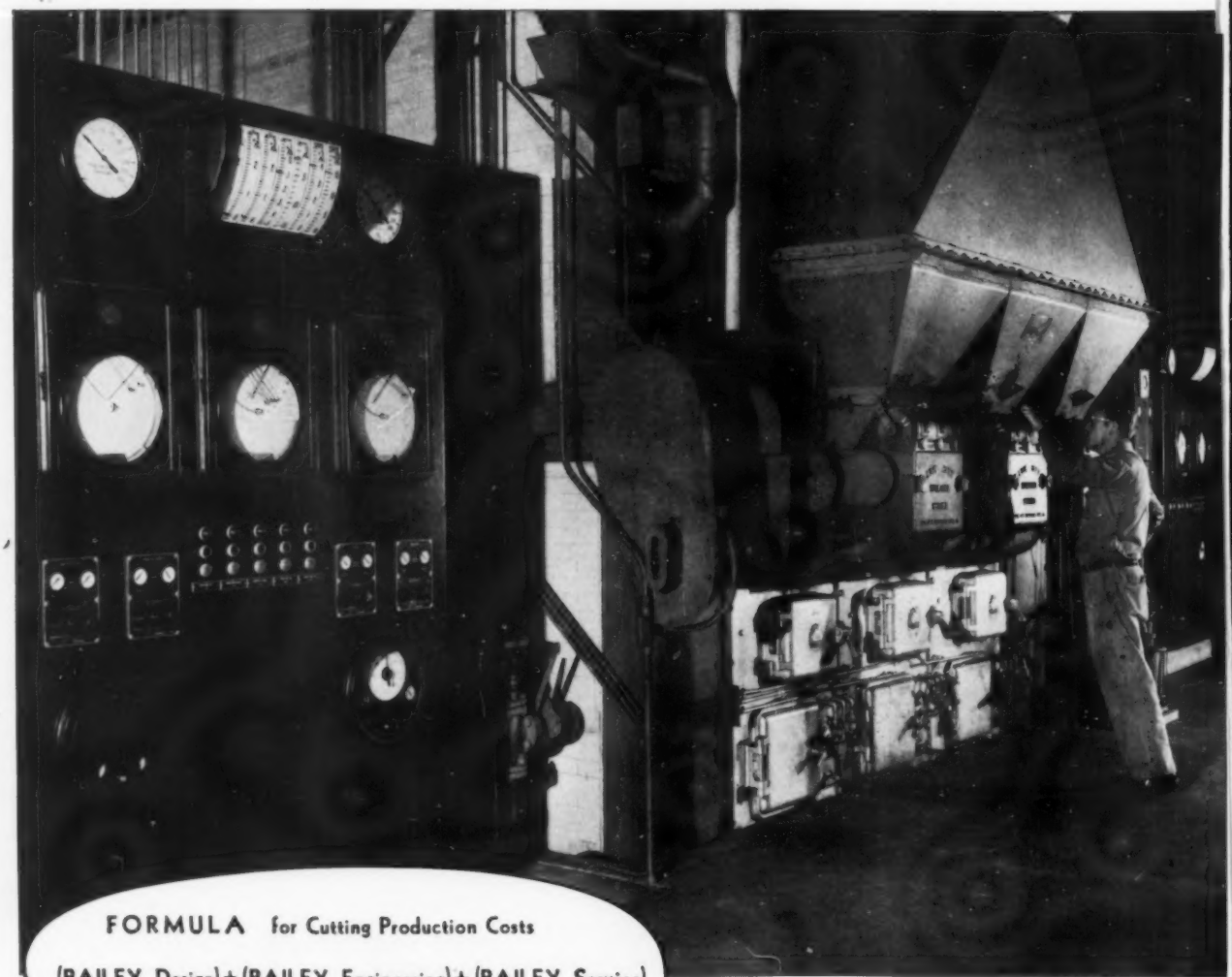
New Engineering Bulletin...

"Fundamentals of Turbine Speed Control" contains 32 pages of the latest information on this important aspect of turbine design and performance. Write for Bulletin H-21 to the Elliott Company, Steam Turbine Department, Jeannette, Pa.

ELLIOTT Company

TURBINE-GENERATORS TURBINES MOTORS GENERATORS DEAERATING HEATERS EJECTORS CONDENSERS COMPRESSORS TURBOCHARGERS TUBE CLEANERS STRAINERS

How to Cut



FORMULA for Cutting Production Costs

(BAILEY Design) + (BAILEY Engineering) + (BAILEY Service)

= GREATER SAVINGS PER FUEL DOLLAR

At the heating plant of Lincoln Electric Co., Euclid, Ohio Bailey Control helps to cut operating costs by:

1. Controlling the rate of combustion in two spreader stoker-fired hot water boilers to maintain the desired temperature of outlet water.

2. Controlling fuel-air ratio at each boiler by means of a unique Btu-Air Flow meter which maintains most economical use of fuel.

3. Controlling quantity of water by-passed around boilers, thus tempering water supplied for heating in accordance with changes in outside temperature.

Operating Cost

★ When your plant is operating at peak efficiency, unit production costs are low. But outages of any kind upset the balance. As efficiency drops, and/or outages occur, overhead costs impose an increasing burden—bring on dollar losses that can't be recovered.

That's why you can use Bailey Co-ordinated Control Systems to advantage. Here are three reasons why Bailey systems are the best you can buy:

1. Complete Range of Equipment—fully co-ordinated

You need never worry that a Bailey Engineer's recommendation is slanted in favor of a particular type of equipment, just because he has a limited line to sell—or that Bailey will pass the buck for efficient control; we offer *complete* boiler control *systems*.

2. Engineering Service—backed by experience

No other manufacturer of instruments and controls can offer as broad an experience, based on successful installations involving all types of combustion, flow measurement, and automatic control.

3. Direct Sales-Service—conveniently located near you

Bailey Meter Company's sales service engineers are located in more industrial centers than those of any other manufacturer of boiler control systems; you get prompt, experienced service with a minimum of travel time and expense.

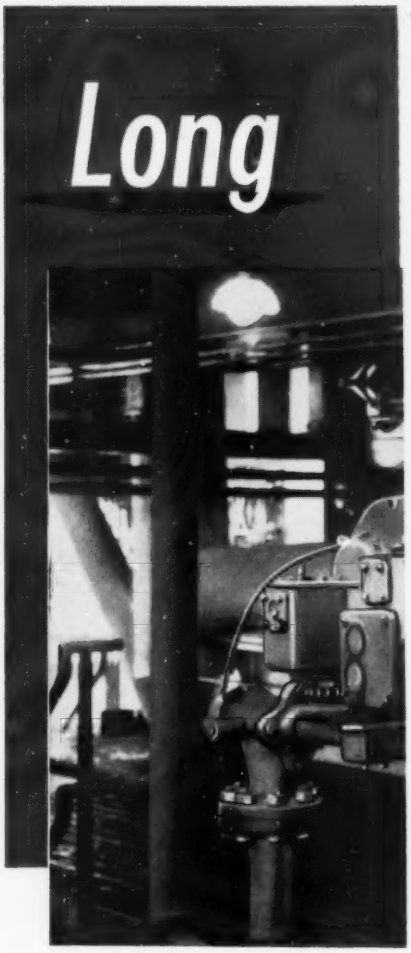
For lower operating cost—for more power per fuel dollar, less outage, and safer working conditions, you owe it to yourself to investigate Bailey Controls. Ask a Bailey Engineer to arrange a visit to a nearby Bailey installation. We're proud to stand on our record: "More Power To You!"

A-119A-2

BAILEY
METER COMPANY
1036 IVANHOE ROAD
CLEVELAND 10, OHIO
Complete Controls for Steam Plants

BAILEY METERS
Controls for
COMBUSTION
FEED WATER
TEMPERATURE
PRESSURE
LIQUID LEVEL
FEED PUMPS

VULCAN *because of...*



DUAL MOTOR DRIVE

Vulcan uses two motors. One extends and retracts the lance. The other rotates it. Motors may be air or electric. Speeds are independently adjustable.

JET AND LANCE DESIGN

Vulcan offers jets tailored to the job—straight bore or venturi; and angled to reach specific surfaces. Jets normally rotate while traversing, but may traverse only or oscillate through any angle. Lances from opposite sides of the furnace may fail to "meet" by as much as 12 feet, yet clean thoroughly.

CHOICE OF BLOWING MEDIUM

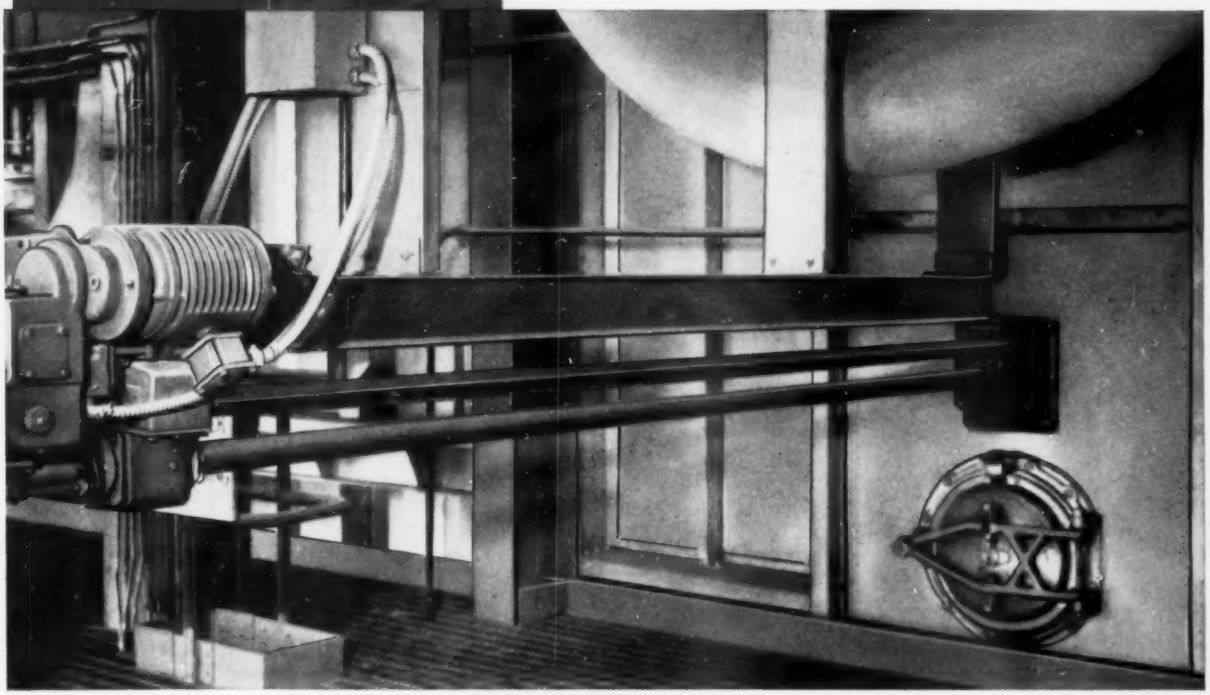
You can blow with any medium—air, steam or water, or any combination of them—*without change of equipment.*

CHANGE OF PACE

Two motors allow stop-and-go indexing with uniform rotation—or fast-and-slow change of pace. On "stop and go," the lance is stopped and rotated to clean the tubes—then sped across the open areas to the next row of tubes. On "fast and slow," the lance is slowed to clean the tubes, and sped while passing open areas. In each case, the result is a saving of blowing medium.

VULCAN Automatic

Retracts clean better



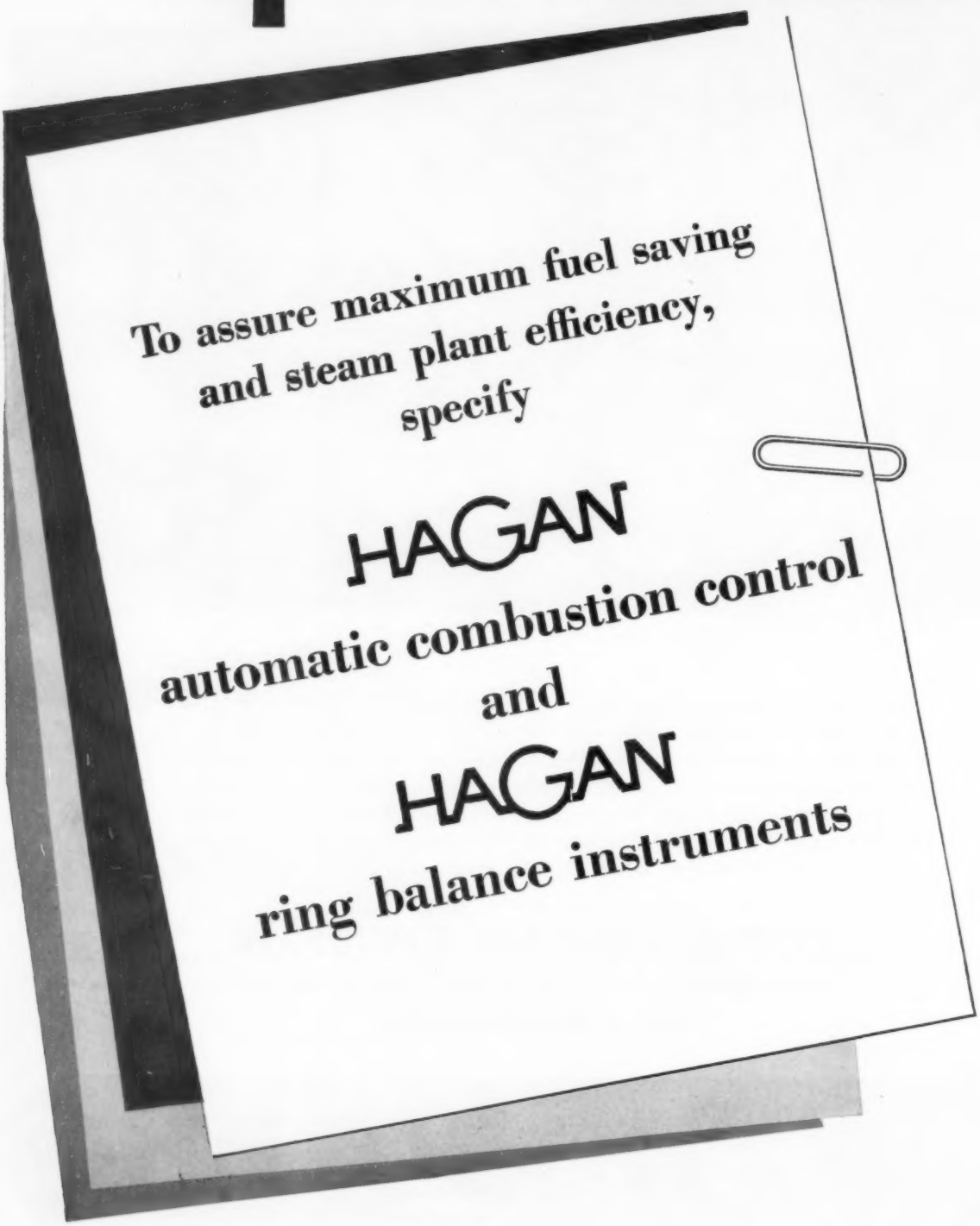
Vulcan Long Retracts clean better—with fewer outages, at lowest cost. They are engineered for optimum performance under varying conditions. They work equally well at any angle. They give you the benefit of dual-motor operation—one motor to traverse the lance, a second to rotate it. *Rotation is always in the same direction.* Repeated cleaning cycles result in an infinite number of double-helix paths that continually broaden the cleaning coverage. Lances can pass through as little as four inches of tube clearance. Write for Bulletin 1002.

COPES-VULCAN DIVISION

CONTINENTAL FOUNDRY & MACHINE COMPANY

ERIE 4, PENNSYLVANIA

Specification



for Saving Fuel

The fuel saved by the average system of Hagan Automatic Combustion Control pays back the initial investment within the first year of operation. Comparable savings continue as long as the boilers last. This is a clear profit, amounting to many times the price of the Hagan Automatic Combustion Control.

The indications and records of Hagan Ring Balance Instruments provide the operators with the performance picture necessary for maintaining top efficiencies.

The design and construction of all components stress durability, accuracy and versatility. There is a system of Hagan Automatic Combustion Control and Ring Balance Instrumentation for every boiler plant, with any number or size of boilers, operating at any steam pressure and temperature, and burning all types of fuels, singly or in multiple.

Hagan methods and Hagan equipment are also operating successfully in such applications as:

- Boiler drum water level control, with automatic set point adjustments available.
- Superheated steam temperature control.
- Steam pressure reduction and spillover control.
- Draft or pressure control over a continuous range from fractions of an inch water column to 5000 psig.
- Feedwater heater pressure or temperature control.
- Recording, indicating and integrating flows of water, steam, liquid and gaseous fuels.
- Simultaneous records of two separate flows, measured in a single meter housing.
- Pressure and temperature compensated records of steam and gas flows.
- Density compensated records of boiler drum water level.
- Pneumatic and electric signal transmission for remote recording.

For modernization or extension of existing installations, or for new construction, our engineers will be glad to suggest the best system to fulfill your requirements.

HAGAN CORPORATION

HAGAN HALL BUROMIN CALGON

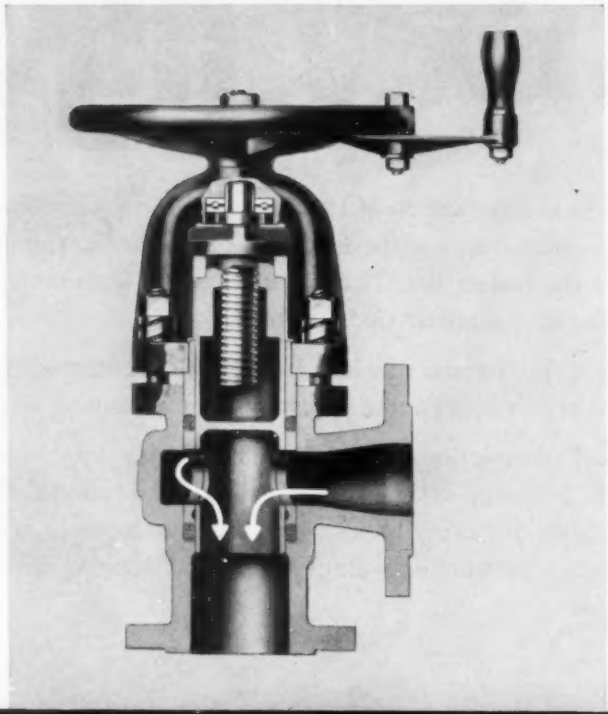
HAGAN BUILDING • PITTSBURGH 30, PENNSYLVANIA

Boiler Combustion Control Systems • Ring Balance Flow and Pressure Instruments • Metallurgical Furnace Control Systems • Control Systems for Automatic and Aeronautical Testing Facilities

These YARWAY VALVE DESIGNS

YARWAY SEATLESS

Features balanced nitralloy hollow plunger that seals line drop-tight, yet permits free, unobstructed flow in blow-down. Other features —laminated packing, alemite lubrication, ball thrust bearings. USED SUCCESSFULLY IN OVER 15,000 BOILER PLANTS.



FOR LOW and MEDIUM PRESSURES

YARWAY HARD-SEAT

Features tough, stellite-faced and ground disc and seat ring, mated to provide smooth long-wearing surfaces. Stream-line flow. Alemite lubrication. MORE THAN 4 OUT OF 5 HIGH PRESSURE BOILER PLANTS USE YARWAY BLOW-OFF VALVES.

FOR HIGHER PRESSURES

USED IN OVER 15,000 BOILER PLANTS

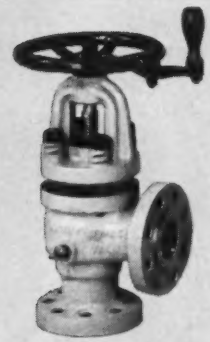
serve every boiler blow-down need

■ Whatever your *pressure* requirement, whatever your *piping* requirement—there's a Yarway Blow-Off Valve to exactly meet your needs.

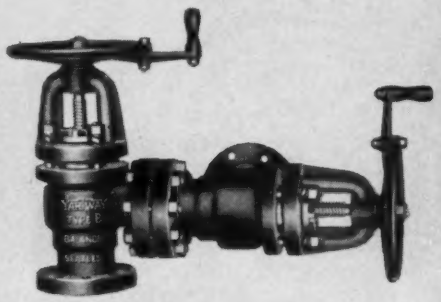
Popular Yarway *seatless* design keeps blow-down lines drop-tight in low and medium pressure ranges. Sturdy Yarway *stellite seat and disc* design protects higher pressures.

All Yarway Blow-Off Valves are strong, rugged valves, built to withstand the punishment of regular or emergency blowing-down under full boiler pressure, and are available in metals that stand up under acid washing of boilers.

Write for new Yarway Blow-Off Valve Bulletins—B-426 (pressures to 400 psi) or B-434 (pressures to 2500 psi).



• Yarway Type B Seatless Blow-Off Valve, iron body for boiler pressures to 200 psi, steel bodies, for pressures to 400 psi. Angle valve shown, straightway available. Flanged connections. See Bulletin B-426.



• Yarway Type B Seatless Tandem Blow-Off Valve combining two angle valves. Other combinations available. Iron bodies for boiler pressures to 200 psi, steel bodies for pressures to 400 psi. See Bulletin B-426.

• Yarway Type C Seatless Tandem Blow-Off Valve combining angle and straightway valves. Other combinations available. Flanged or welding connections available. For boiler pressures to 600 psi. NOTE: When used in tandem with a Yarway Hard-Seat Valve, Type C Seatless may be used to 1500 psi. See Bulletin B-434.

• Yarway Hard-Seat Blow-Off Valve for pressures to 2500 psi. Straightway valve shown. Angle available. Welded (shown) or flanged connections. See Bulletin B-434.

• Yarway Hard-Seat—Seatless Balled Tandem Blow-Off Valve. Hard-Seat is the blowing valve, seatless is the sealing valve. Available in any combination of connections. For pressures to 1500 psi. Hard Hard-Seat cam sundoors for pressures to 2500 psi. See Bulletin B-434.

• Yarway Unit Tandem Blow-Off Valve. Combines a hard-seat blowing valve and a seatless sealing valve in one-piece forged steel body for boiler pressures to 1500 psi. For pressures to 2500 psi, two hard-seat valves are combined. See Bulletin B-434.

LET YARWAY HELP SOLVE YOUR BOILER BLOW-DOWN PROBLEMS!

YARNALL-WARING COMPANY
100 Mermaid Avenue, Philadelphia 18, Pa.
BRANCH OFFICES IN PRINCIPAL CITIES

YARWAY

blow-off valves

Metallic labyrinth bushings, by reducing surface contact between bushing and valve stem, and greatly increasing bushing life, can reduce maintenance costs on the G-E mechanical-drive turbine.

ANOTHER PLUS VALUE OF G-E MECHANICAL-DRIVE TURBINES...

Metallic Labyrinth Bushings Cut Turbine Maintenance Costs

Using metallic labyrinth bushings instead of soft packing on the throttle valve stem and operating valve stem of General Electric's Type DP mechanical-drive turbine has several important advantages. Corrosive attacks on the valve stems, often caused by soft packings, are prevented.

Because surface contact between bushing and valve stem is reduced to a minimum, friction is practically eliminated—bushing life is increased tremendously. This feature alone can save you up to $50.00 in direct maintenance costs—plus the expense of down-time caused by frequent packing replacements.

HERE'S ANOTHER ADVANTAGE. Since frictional drag on the governing system is reduced to a minimum, you get more accurate, sensitive, reliable governing with G.E.'s Type DP turbine.

Metallic labyrinth bushings make an effective steam seal by means of grooves in the bushing which throttle pressure and minimize any steam leakage (see illustration).

THESE METALLIC LABYRINTH BUSHINGS are just one of many DP features which save you money throughout total turbine life. The chart below indicates other areas of savings.

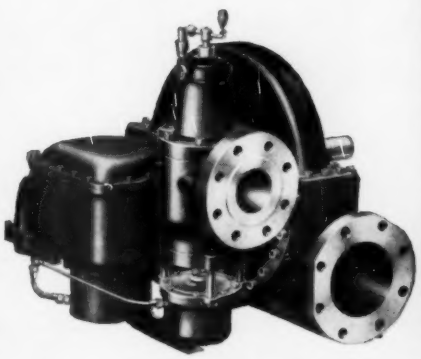
Remember—the total cost is often more than just the sales price. But G.E.'s standard DP turbines include the extra features that save you extra costs. For more information contact your nearest G-E apparatus sales office. Write for bulletin GEA-4955A, "A New Standard in Mechanical-drive Turbines." General Electric, Schenectady 5, N.Y.

252-66

GENERAL ELECTRIC

INSTALLATION AND MAINTENANCE COST-SAVING FEATURES

THESE EXTRA FEATURES, STANDARD ON ALL G-E TYPE DP TURBINES, CAN . . .	Save You up to
COMBINED TRIP-THROTTLE VALVE Eliminate extra cost of buying and installing valve ahead of the turbine.	$200.00
SINGLE RESERVOIR FOR COOLING LUBE OIL Eliminate extra cost of piping cooling water to and between bearings.	50.00
MAJORITY OF PARTS INTERCHANGEABLE One set of spare parts protects several units—less money tied up in inventory.	100.00
METALLIC-LABYRINTH VALVE STEM BUSHING Eliminate labor costs of replacing soft packings; cut down-time production losses.	50.00
SHAFT MONEL-SPRAYED AT PACKING FIT Saves frequent cost of purchasing and installing carbon rings; contributes to long shaft and packing life.	20.00
ESTIMATED TOTAL SAVINGS	$420.00

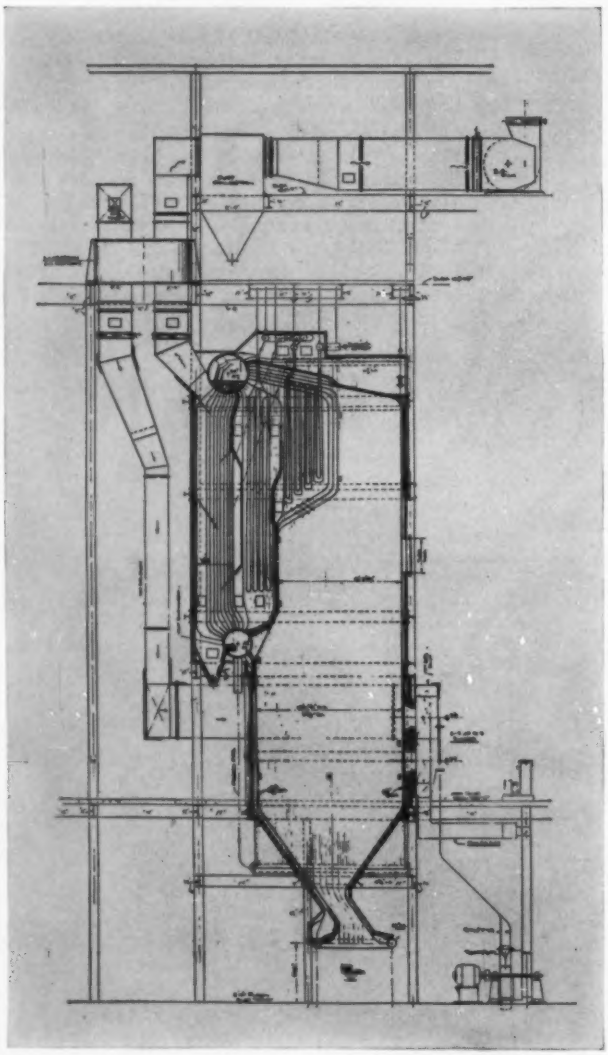


G-E Type DP Mechanical-drive Turbine

COMPARE THE FEATURES
EVALUATE ALL THE COSTS

See why G-E Standard Type DP turbines are your most economical buy.

NEW IOWA ELECTRIC LIGHT AND POWER COMPANY PLANT EQUIPPED WITH



New Iowa Electric Light and Power Company Sutherland Station at Marshalltown, Iowa. This is a 300,000 pounds of steam per hour Riley steam generating unit. Design pressure 975 with steam temperature 910°F. Operation is scheduled for fall, 1954. Duplicate unit will be ready in 1955.

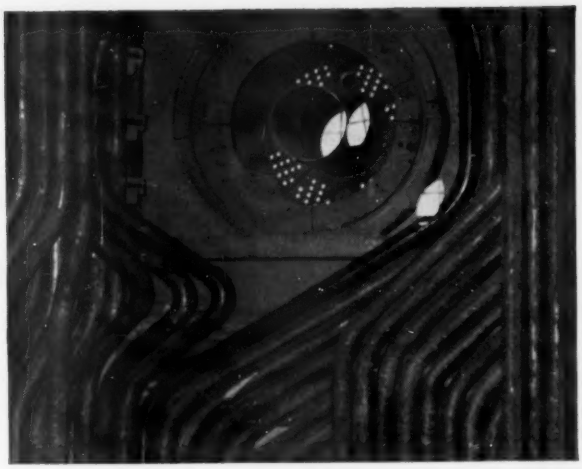
TO HELP MAKE SURE they get the power they've bought, this Midwest utility has a new plant equipped with Republic ELECTRUNITE Boiler Tubes.

One reason is dependability. ELECTRUNITE Boiler Tubes are made from high grade steel, produced in Republic's own mills. From the time the ore is mined, through manufacturing stages, operations are quality controlled.

The results: Tubes with uniform wall thickness which give uniform heat transfer, all around the tube, from end to end. Uniform ductility for

Some Recent ELECTRUNITE Boiler Installations

Edwardsport Station, Public Service Co. of Indiana
National Petro-Chemicals Co., Tuscola, Ill.
Municipal Light Plant, Orville, Ohio
B. F. Goodrich Co., Akron, Ohio
Capitol Power Plant, Washington, D. C.
Riegel Textile Corp., Trion, Georgia
Superior Water, Light and Power Co., Superior, Wis.
Ford Motor Co., Dearborn, Mich.
Murray-Ohio Manufacturing Co., Cleveland, Ohio
Central Ohio Light & Power Co., Findlay, Ohio
International Harvester Co., Chicago, Ill.
Sloane-Blabon Corp., Trenton, N. J.
Mid-Continent Petroleum Corp., Tulsa, Okla.
Swift & Co., Hammond, Ind.
City of Provo, Provo, Utah
Kennecott Copper Corp., Hayden, Ariz.
Missouri Power & Light Co., Mexico, Mo.
Gilbert Paper Co., Menasha, Wis.
Morton Salt Co., Manistee, Mich.



Uniform ductility of ELECTRUNITE *Boiler Tubes permits accurate bends to be made easily. Spring-back can be calculated before the bending operation.*

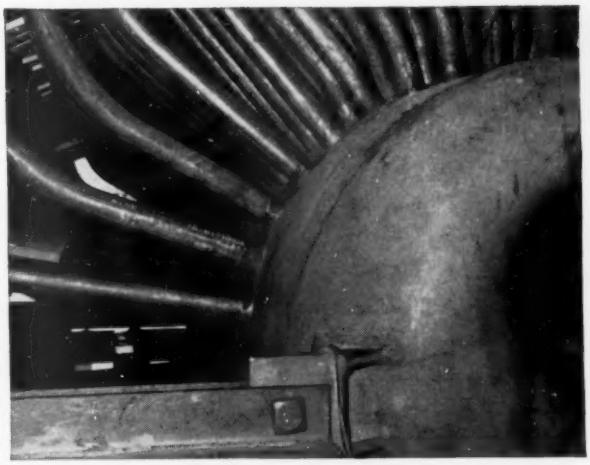
ELECTRUNITE

BOILER TUBES

smooth bending and smooth roller expanding.

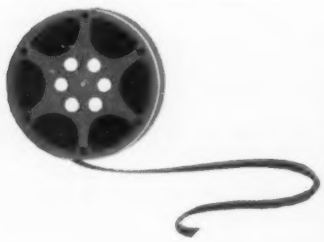
ELECTRUNITE Boiler Tubes also pay off from the standpoint of economics. Before you plan your next power expansion, or modernization, consider Republic ELECTRUNITE Boiler, Condenser and Heat Exchanger Tubes. Write for the booklet CEC-54 which gives you complete data and specifications.

REPUBLIC STEEL CORPORATION
Steel and Tubes Division
221 E. 131st Street, Cleveland 8, Ohio
GENERAL OFFICES • CLEVELAND 1, OHIO
Export Department: Chrysler Building, New York 17, N. Y.



Surfaces of ELECTRUNITE *Boiler Tubes are scale-free because they are normalized in a controlled atmosphere. No grinding tube ends, which destroys uniformity. Tubes slide into drum holes easily, expand uniformly.*

"Intestinal Fortitude"—16mm. sound, black and white film, 17 minutes. The story of ELECTRUNITE *Pressure Tubes from ore to finished product. To arrange for a showing, write to Steel and Tubes Division.*



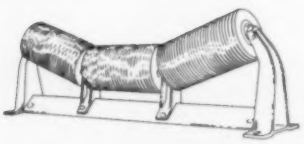
Republic
REPUBLIC STEEL
ELECTRUNITE
BOILER, CONDENSER AND HEAT EXCHANGER TUBES

INTRODUCING:
Jeffrey Belt Idler Series HD and MD with DUOFLEX seal

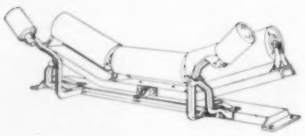
Years of customer research, laboratory development and field testing have produced this great advancement in the art of belt conveying. Built strong and well balanced for long, trouble-free service. Write for details.

(PATENTS APPLIED FOR)

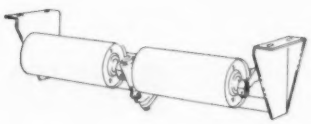
a type and size for every need...



IMPACT ABSORPTION IDLER



TROUGHING TRAINING IDLER

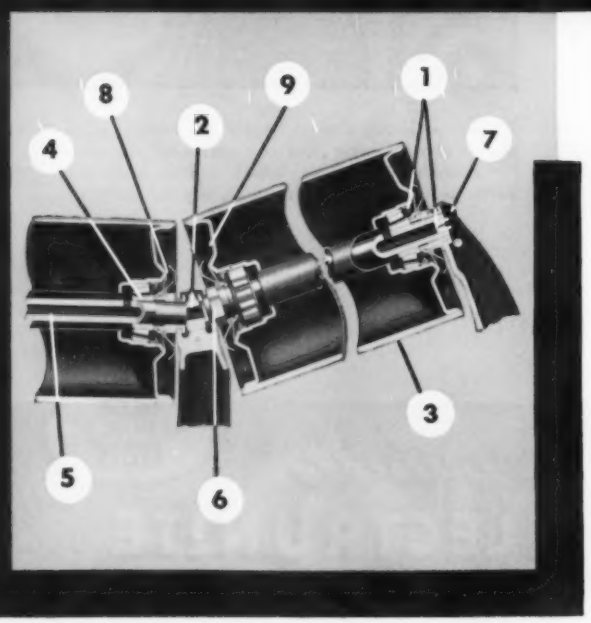


RETURN TRAINING IDLER

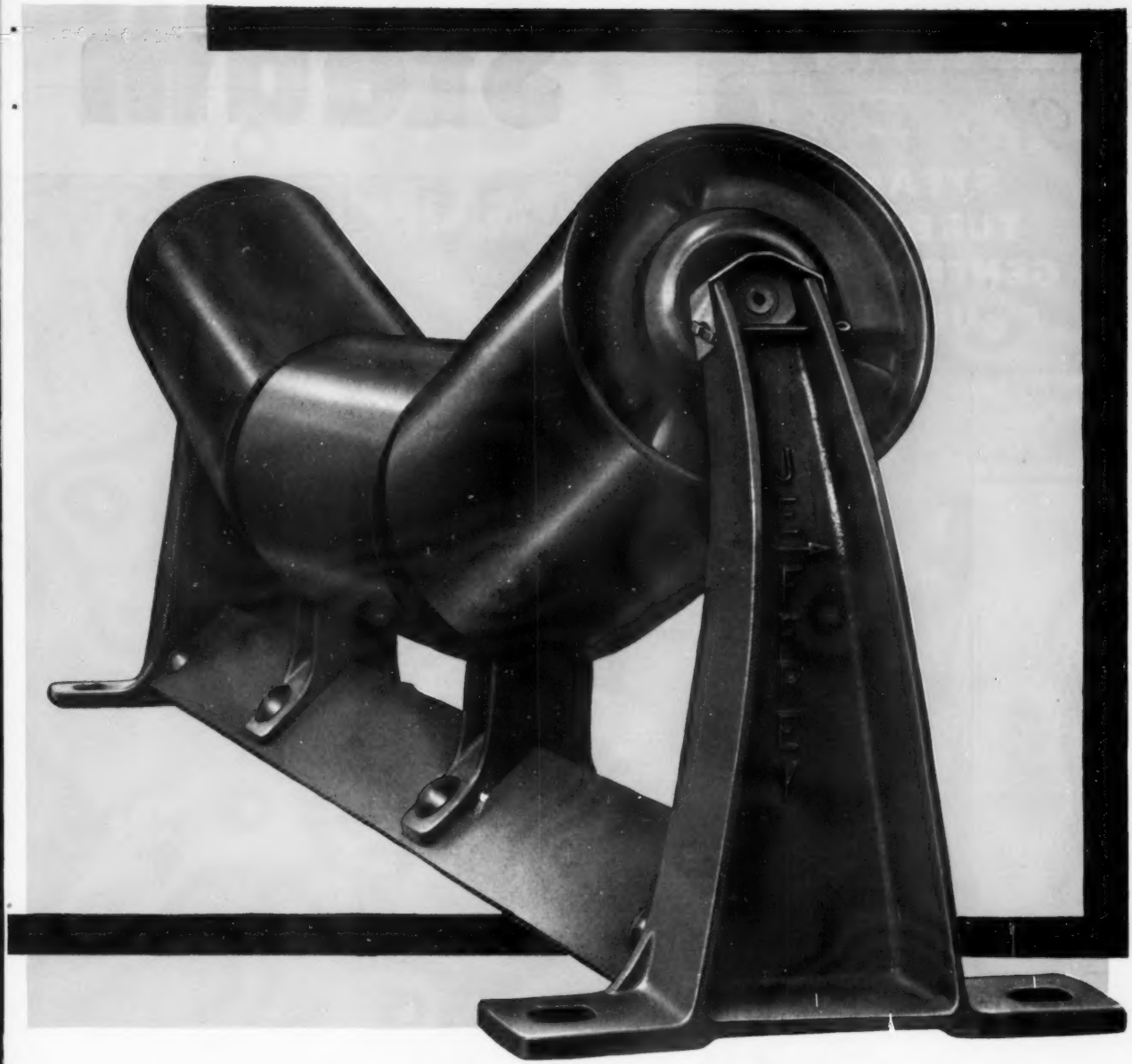
SPOOL RETURN IDLER

RETURN IDLER

SPOOL RETURN TRAINING IDLER



1. Factory lubricated, adjusted and permanently sealed with two flexible contact seals to keep dirt out and belt-damaging grease in, *for the life of the idler.* Fitted with vented plugs to prevent promiscuous relubrication.
2. Where desirable to relubricate or freshen the grease after long operating periods, "Neoprene" shaft connectors provide for relubrication from either end.
3. Heavy, welded steel pipe of uniform wall thickness. Roll ends machine smoothed to protect belt and workmen.
4. High-capacity tapered roller bearings snug-fit on shafts.
5. Stationary, tubular shafts with fine threads for minute bearing adjustment.
6. Entire assembly locked by grooved hex nuts which transfer load to stands.
7. Removable straps on center and end stands lock rolls in place during shipment and operation . . . facilitates removal of rolls.
8. Outer shields provide protection for seals.
9. Formed steel ends pressed and welded into place for maximum strength and true running rolls.



20° TROUGHING IDLER . . . locked-in roll assemblies form truss type construction . . . balanced design gives perfect distribution of weight and stresses . . . 2° tilted end stands for engineered belt training . . . minimum space between rolls prevents damage to belts . . . die straightened, high-strength, streamlined stands set up maximum strength-to-weight ratio . . . self-cleaning, inverted angle base . . . mounting feet cast integral with end stands to develop full strength of the idler . . . all types designed to provide the best in belt conveying operations.

THE JEFFREY MANUFACTURING CO.

ESTABLISHED 1877

Columbus 16, Ohio

sales offices and distributors in principal cities

PLANTS IN CANADA, ENGLAND, SOUTH AFRICA.

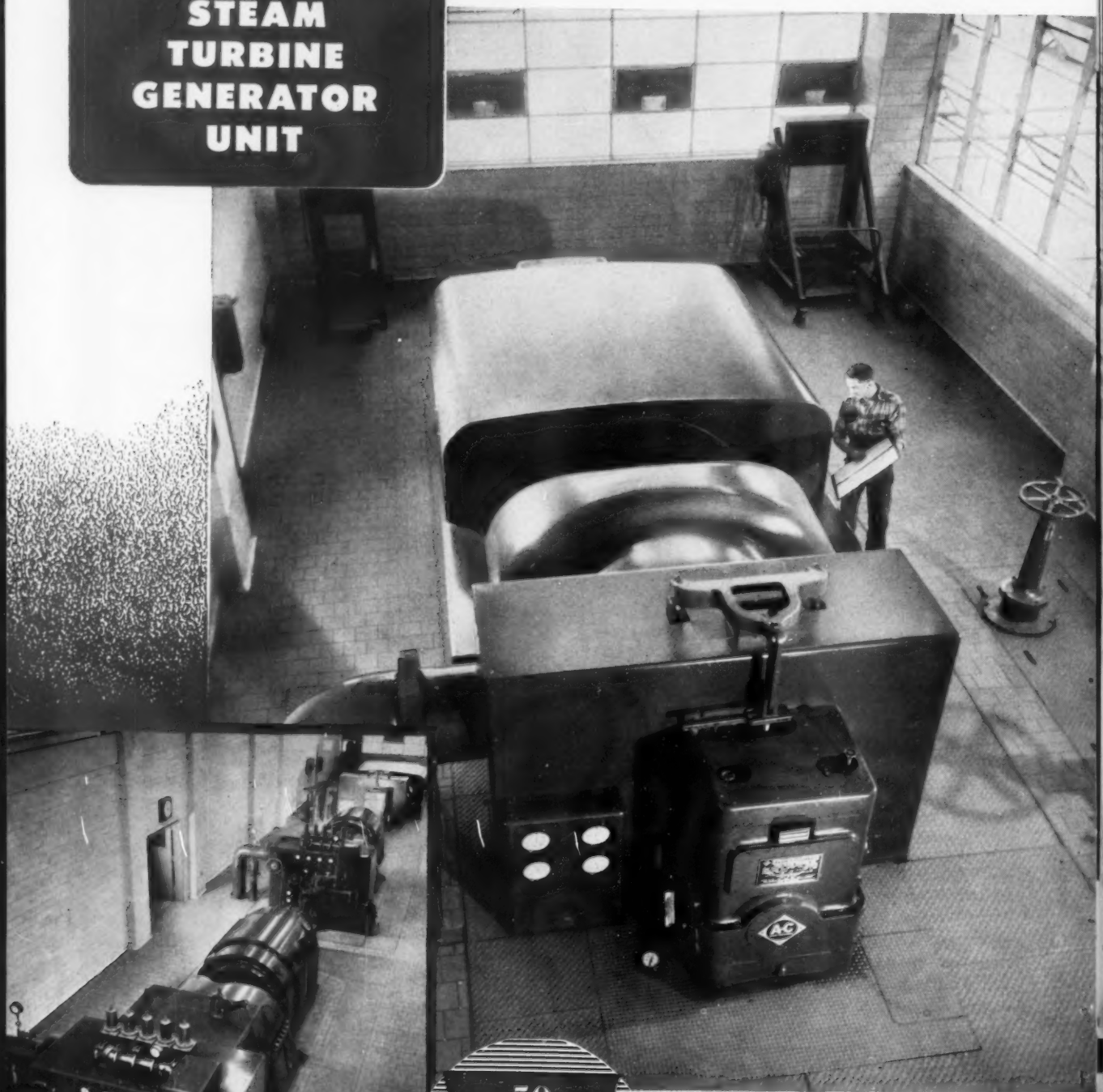
IF IT'S MINED, PROCESSED OR MOVED

. . .IT'S A JOB FOR JEFFREY!

Steam

WA-Series

STEAM TURBINE GENERATOR UNIT

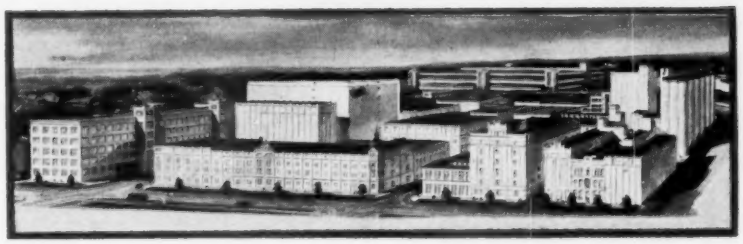


50 YEARS TURBINE

ALLIS-

Works Twice

FOR WORLD-FAMOUS BREWER



Jos. Schlitz
Brewing Company
Uses Steam for Both Processing
and Power Generation

Great quantities of steam are required for production of the "beer that made Milwaukee famous" at a rate exceeding six million barrels of beer a year. With so much steam needed for process, the electric power needed for plant operation is generated as a by-product.

At the Schlitz home plant in Milwaukee, two Allis-Chalmers 2500-kw, automatic extraction condensing turbine-generator units have been supplying process steam and electric power for the past five years. Recently, when more generating capacity was needed to match rapid plant expansion, Schlitz again turned to Allis-Chalmers.

Now operating 24 hours a day, 7 days a week, the new 5000-kw turbine-generator shown here was installed in the space originally planned for a third 2500-kw unit. It consists of a condensing, automatic extraction, impulse turbine and a housing type, air-cooled generator and exciter all carefully engineered and manufactured to operate as an integrated unit.

Built for condensing or non-condensing service in NEMA standard ratings 2000 kw and larger, the modern WA-Series unit is designed to meet modern power plant requirements. Bulletin 03B7654 gives complete details. For your copy, just call your nearby A-C representative, or write Allis-Chalmers, Milwaukee 1, Wisconsin. A-4269

WA-Series Features

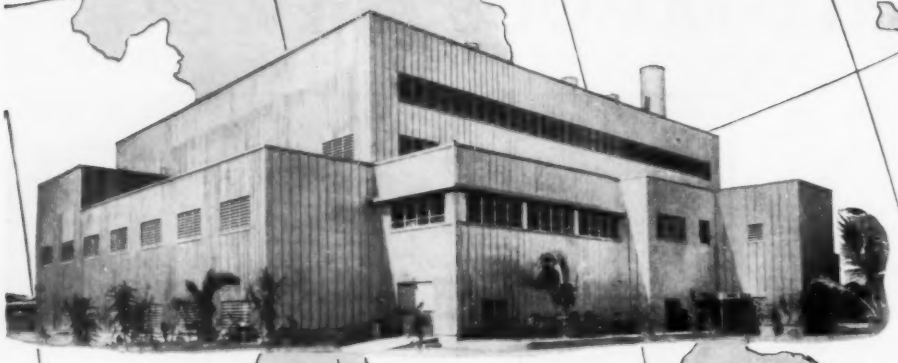
For easy installation and maintenance, every detail of the unit is designed for maximum simplicity. Three-bearing construction; above-the-floor oil piping; bracket-bearing, housing-type air-cooled generator — all result in a compact unit that simplifies foundation requirements. Shipment of the turbine and the generator with their rotors in place further minimizes installation time.

Maximum reliability is assured by labyrinth spring-backed steam seals throughout, removable external glands, high chrome alloy steel buckets and nozzles, and time-proved governing system.

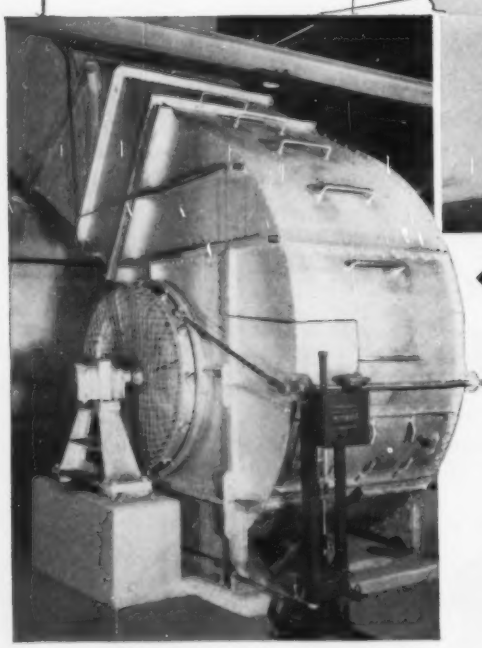
CHALMERS

A-C ALLIS-CHALMERS

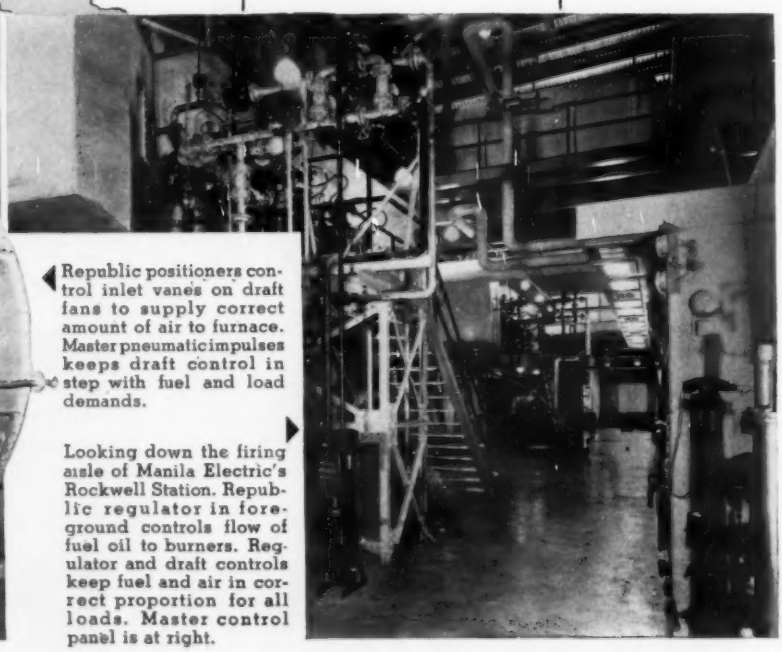
IN THE PHILIPPINES . . .



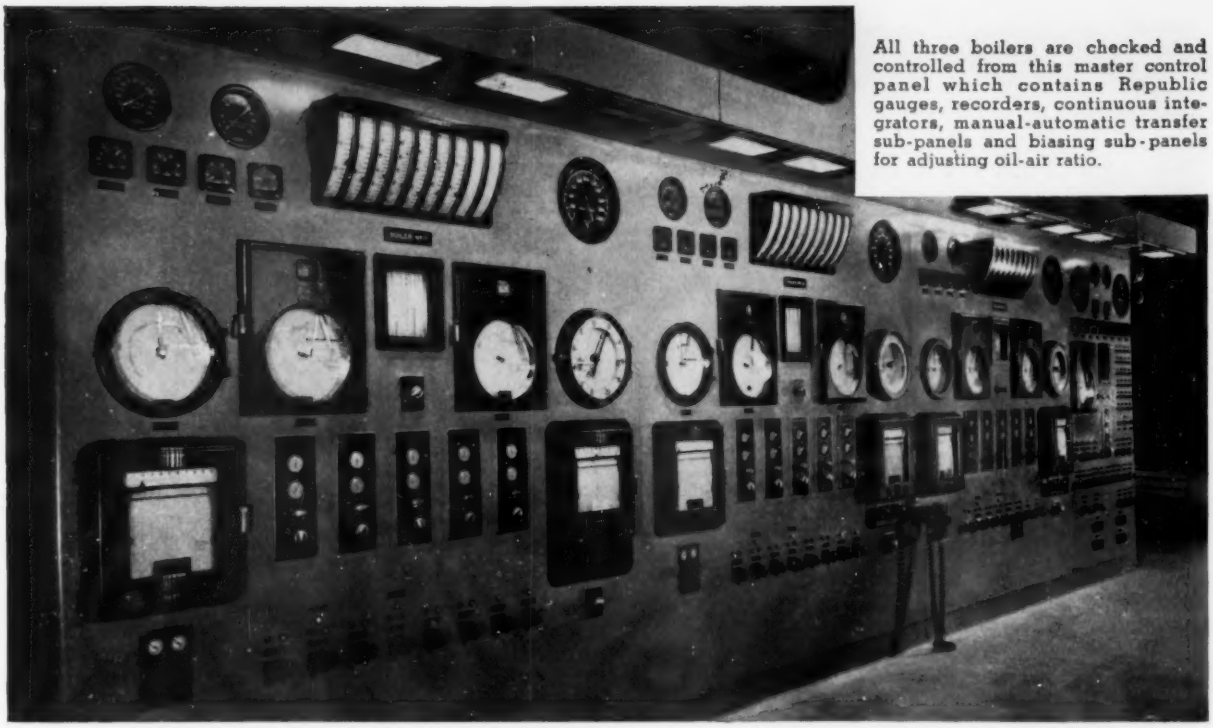
MANILA ELECTRIC Rebuilds . . . .



Republic positioners control inlet vanes on draft fans to supply correct amount of air to furnace. Master pneumatic impulses keeps draft control in step with fuel and load demands.



Looking down the firing aisle of Manila Electric's Rockwell Station. Republic regulator in foreground controls flow of fuel oil to burners. Regulator and draft controls keep fuel and air in correct proportion for all loads. Master control panel is at right.



All three boilers are checked and controlled from this master control panel which contains Republic gauges, recorders, continuous integrators, manual-automatic transfer sub-panels and biasing sub-panels for adjusting oil-air ratio.

installs **REPUBLIC** *Automatic*

COMBUSTION CONTROLS to get maximum combustion efficiency

1945. Manila is a shambles. Rebuilding of pre-war power equipment starts. But power demands skyrocket. It's necessary to bring in a floating 30,000 kw power station to meet the emergency. Electrical demand grows until it is even more than pre-war power facilities can handle. Distribution transformers must be worked until the insulating oil boils; sub-station transformers must be constantly cooled with a water spray; wires turn cherry red because the overloads are so great.

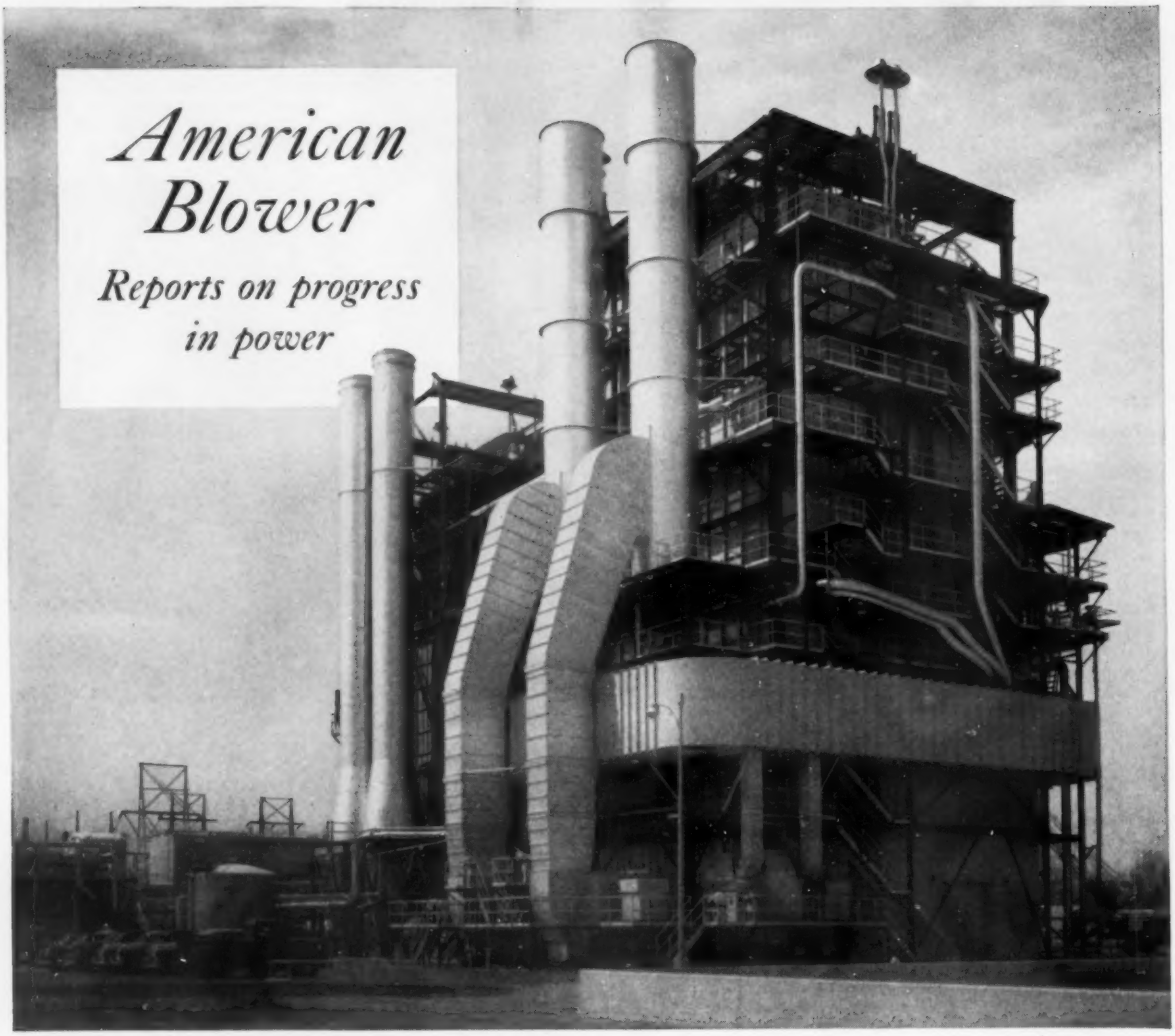
That was the Manila power situation after the war. Now, Manila Electric Company, who had to meet this demand, is over the "hump." One big reason is its modern new power station which is capable of generating 50,000 kw. Designed by Gilbert Associates, Inc., it contains three oil-fired boilers, each rated at 250,000 lbs. per hr. at 875 psig and 910° F. To maintain the operation of these boilers at maximum efficiency under all load conditions, Republic Automatic Combustion Controls have been installed. Pressure reducing valves and controls plus feedwater pump controls were also furnished by Republic.

This is but one example of power stations all over the world that are equipped with Republic Combustion Controls. Recent over-seas installations include stations in Italy, Greece, Chile, India and Australia.

Wherever the station, whatever the fuel, draft arrangements or load characteristic, Republic Combustion Controls can operate boilers to hold fuel and air in the correct amounts and proportion for maximum combustion efficiency.

Get the details in Data Book S-21 or contact your nearby Republic field engineer.

REPUBLIC FLOW METERS CO. ● 2240 DIVERSEY PARKWAY • CHICAGO 47, ILLINOIS



● Up-to-date Ninemile Point Plant, near New Orleans, will have 310,000 kw capacity, when a third steam generating unit is completed in 1955. LP&LC's other steam-electric plant, Sterlington Station, has 146,000 kw capacity.

Louisiana Power installs the first

American Blower plays an important role in the LP&L Co. expansion program

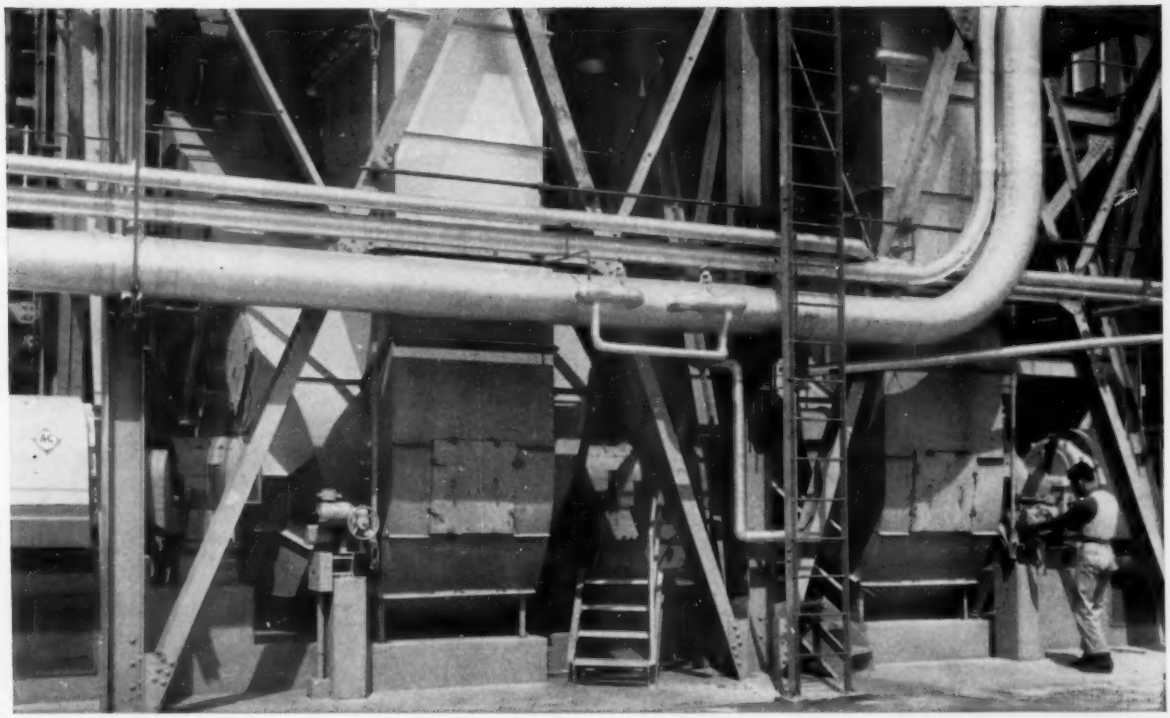
Scheduled for completion in early 1955, the third unit of Louisiana Power & Light Company's Ninemile Point Plant will be the first gas-fired unit in the country to employ the reheat cycle. By re-heating steam in the boiler after it has done part of its work in the turbine, the reheat cycle promises fuel savings and greater operating efficiency!

The new unit will boost capacity at Ninemile Plant to 310,000 kw. Its boiler will stand 14 stories high, have a high-speed elevator for rapid access to all operating levels and will be capable of producing 1,000,000 lbs. of steam per hour at a pressure of 1,525 pounds per square inch at 1,005° F.

Another unique feature at Ninemile Point Plant will be the commercial use of television for supervising the burning of natural gas in the boiler furnace. The control room operator will be able to light, adjust and control the furnace gas burners without leaving his station!

American Blower Forced and Induced Draft Fans

Serving home and industry: AMERICAN-STANDARD • AMERICAN BLOWER • CHURCH SEATS & WALL



● Two American Blower Induced Draft Fans are installed in the Ninemile Point Plant. Each has capacity of 143,500 cfm at 695 rpm with 8.3" sp. Driving power required is 319 hp.

● This is one of two American Blower Forced Draft Fans at the Ninemile Point Plant. Each has a capacity of 78,000 cfm at 9.07" sp when operating at 1160 rpm requiring 164 hp.

gas-fired unit with reheat cycle!

have played an important part in LP&LC's expansion program. American Blower also makes Dust Collecting Equipment, Fly Ash Precipitators and Gyrol Fluid Drives for boiler feed pump and fan control.

If you plan to modernize or expand your facilities, talk over your problems with any American Blower engineer. His knowledge of the application of air-handling equipment and Gyrol Fluid Drives can prove invaluable to you. Contact your nearest American Blower Branch Office, or write us direct.

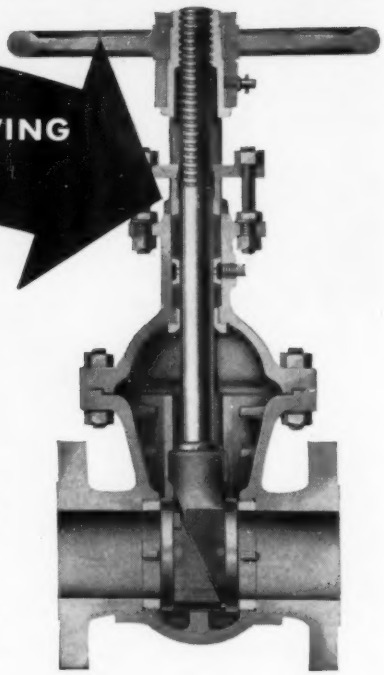
AMERICAN BLOWER CORPORATION, DETROIT 32, MICHIGAN
CANADIAN SIROCCO COMPANY, LTD., WINDSOR, ONTARIO
Division of American Radiator & Standard Sanitary Corporation

AMERICAN BLOWER

TILE • DETROIT CONTROLS • KEWANEE BOILERS • ROSS EXCHANGERS • SUNBEAM AIR CONDITIONERS

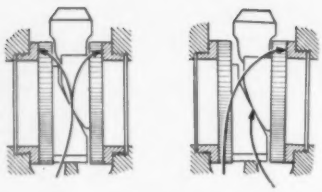
2 WAYS TO GET BETTER VALVE SERVICE!

1 ...UNIQUE DARLING DOUBLE REVOLVING DISC, CAST STEEL GATE VALVE



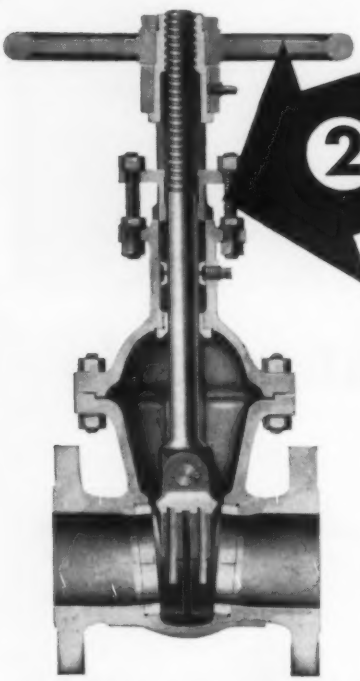
YES, here's a sure way to get better, more dependable valve service. Install this Darling gate valve of the fully revolving double disc, parallel seat type. Time after time users rate it number one for the elimination of down-time and repeated maintenance headaches.

Check the diagrams at right. Note how this Darling gate valve automatically compensates for body distortion, and resulting misalignment of seats. The upper wedge face is radiused, while the lower wedge face is straight, thus disc-to-seat pressure is equalized, assuring tight closure despite distortion and wear.



Discs and seats are parallel. *Seats forced out of parallel by body distortion but discs adapt themselves to give positive closure.* *Radiused face of wedge allows discs to adjust tightly against both seats.*

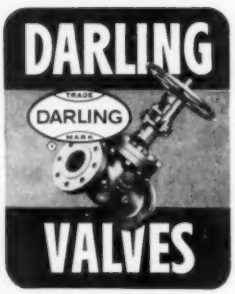
For foolproof simplicity in maintenance and reassembly, and unequalled service life, install this superior Darling Cast Steel Gate Valve.



2 ...DARLING SLOTTED WEDGE CAST STEEL GATE VALVE

HERE'S the second good way to get better valve service. This Darling gate valve's slotted wedge provides *flexibility* when it's needed! It automatically compensates for expansion and contraction due to temperature changes, avoids leaks and minimizes wear and tear on the wedge faces and seats.

What's more, the wedge has *double* guide grooves which engage twin ribs in the valve body. This provides twice the usual bearing area, assuring smooth trouble-free alignment every time!



FOR PLUS VALUES, JOB-PROVED AGAIN AND AGAIN

EVERY NEED. *Darling gate valves are made in a wide range of sizes, types and constructions for all kinds of normal and unusual service . . . and for pressures up to 1500 pounds.*

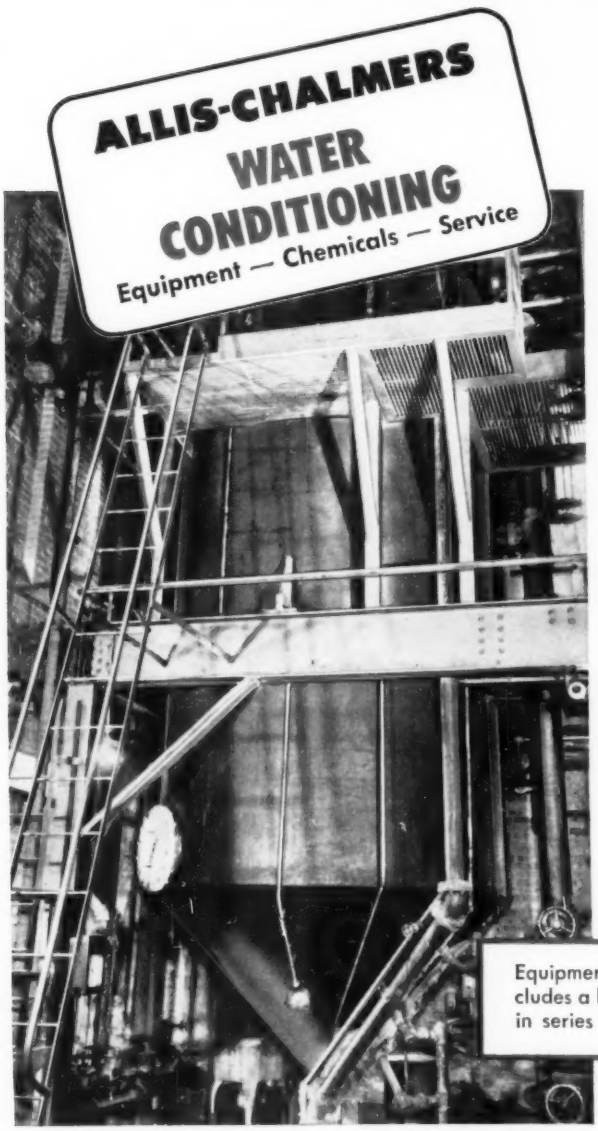
DARLING VALVE & MANUFACTURING CO.

Williamsport 8, Pa.

Manufactured in Canada by Sandilands Valve Manufacturing Co., Ltd., Galt 19, Ontario

Minneapolis Gas Co., Minneapolis, Minn., Gets...

MORE BOILER FEEDWATER



How to increase feedwater supply without adding excessively to chemical and equipment costs? That was the problem at Minneapolis Gas Company, Minneapolis, Minn., when installation of new equipment increased demands on the power plant.

Allis-Chalmers water conditioning engineers solved this problem with a hot lime, ion exchange system that provides zero hardness, extremely low silica content, low alkalinity and low CO_2 in steam. Chemical costs are very reasonable, since only salt and lime are needed. An added dividend can come from the small amount of space required for equipment — for example, in one installation of this type, the resin tanks are tucked under the basement stairs.

Solve Any Water Problem

You can find a solution to any water conditioning problem by consulting with an Allis-Chalmers water conditioning expert. Allis-Chalmers will provide analysis and a complete recommendation, in addition to supplying you with the chemicals and equipment you need.

If you would like to learn more about the hot lime, ion exchange process outlined above, get a copy of Allis-Chalmers Water Conditioning Informational Bulletin 49 from your nearby A-C district office, or write Allis-Chalmers, Milwaukee 1, Wisconsin.

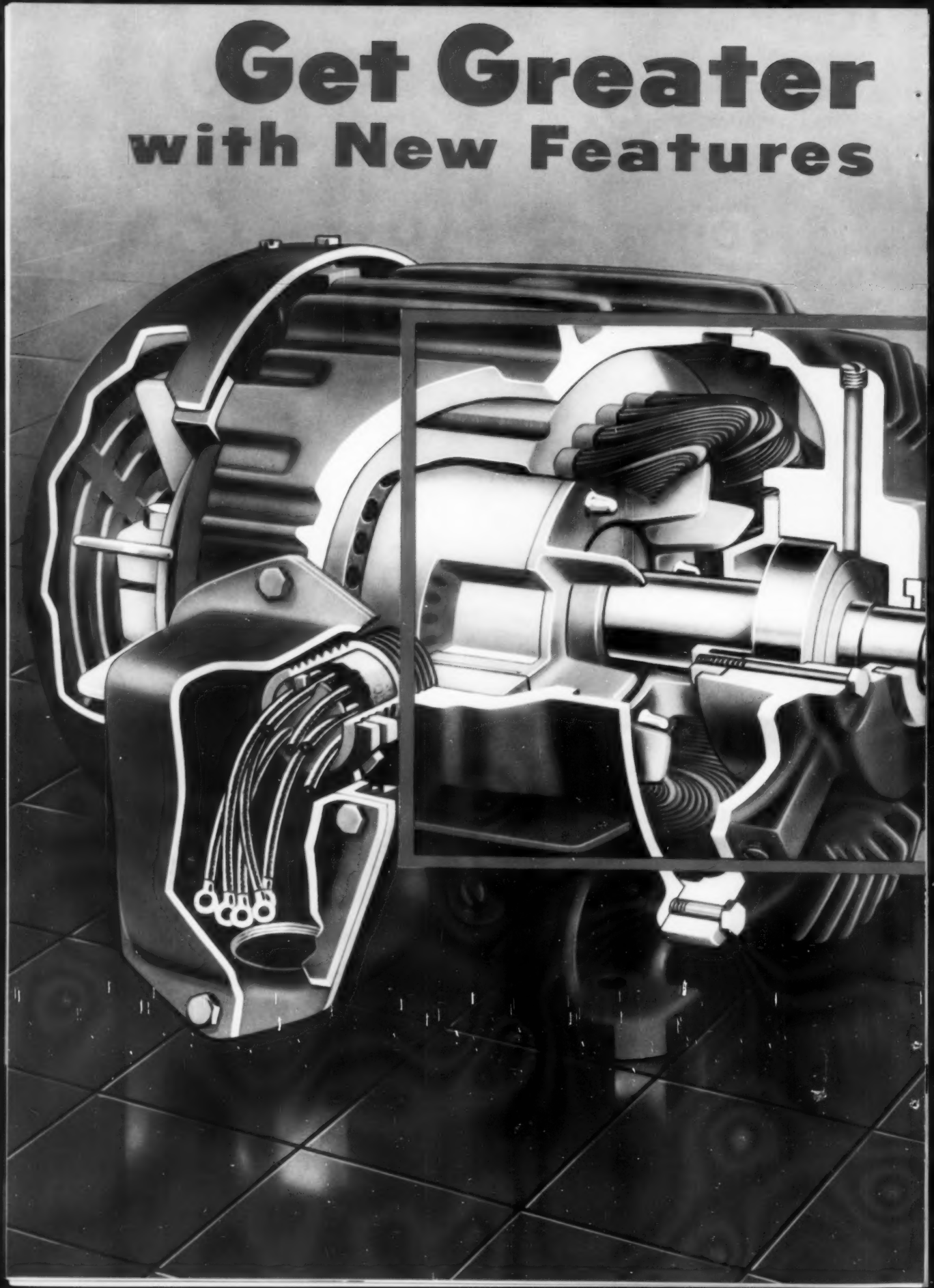
A-4403

Equipment similar to this at Minneapolis Gas Co. includes a hot process lime-soda softener which is placed in series with the hot zeolite (ion exchange) unit.

ALLIS-CHALMERS

A-C ALLIS-CHALMERS

Get Greater
with New Features

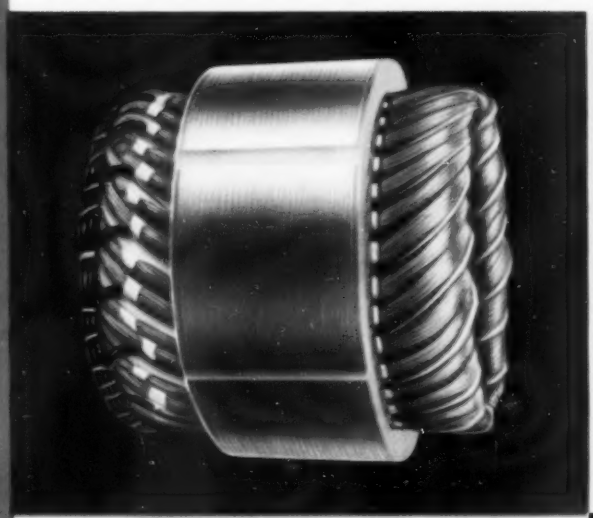


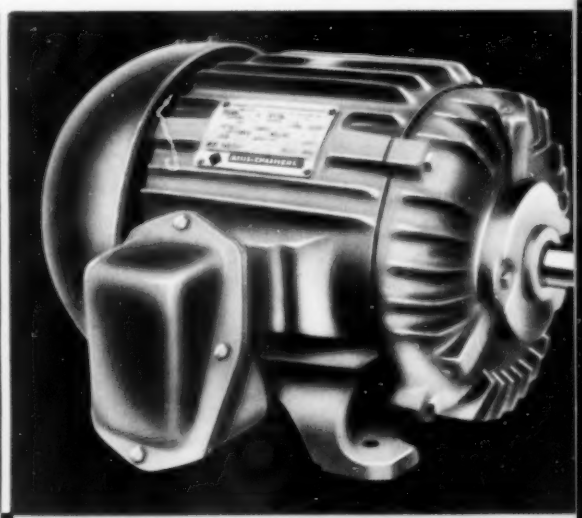
Motor Economy
. . . Proved Principles

Here's the inside story of a great new motor. It combines the best of the new developments in methods and materials with the best of the tried and proved principles that have made such an outstanding record for Allis-Chalmers motors.

Smaller in size than previous design, it retains the easy-to-clean, fin-type construction which Allis-Chalmers pioneered several years ago. The bearing design gives greater bearing protection, ease of maintenance and long life. Insulation gives you famous Allis-Chalmers rugged dependability.

Consult your nearby Allis-Chalmers Authorized Distributor or District Office on your motor needs. Or write for Bulletin 51B6210.





STATOR DOUBLE INSULATED —Stator laminations are welded across back for rigidity. Heavy varnished cambric insulation is inserted between phase windings. Wound stator is dipped several times in special insulating varnish of proved effectiveness and stamina, and baked after each dip. The Allis-Chalmers stator is both physically and electrically strong . . . thoroughly protected against moisture, heat and corrosion.

FIN-TYPE CAST-IRON FRAME — Proved by years of service. Cooling ribs are cast integrally with the yoke; air is blown over them without restriction. There are no enclosed external air passages to clog up with dirt and thereby ruin cooling efficiency. Radiating surface provides reserve cooling capacity for extra strenuous duty. Cleaning, if required, is a few moments work with an air hose, brush or vacuum cleaner.

Multiple bearing protection keeps grease in... keeps dirt out...permits relubrication in service

Extreme care has been taken to provide longest possible bearing life and lowest possible maintenance costs. The bearing itself is of double-shielded type, which allows controlled migration of grease in and out of the bearing to suit operating conditions. Yet bearing is protected against greatest cause of bearing trouble — overgreasing.

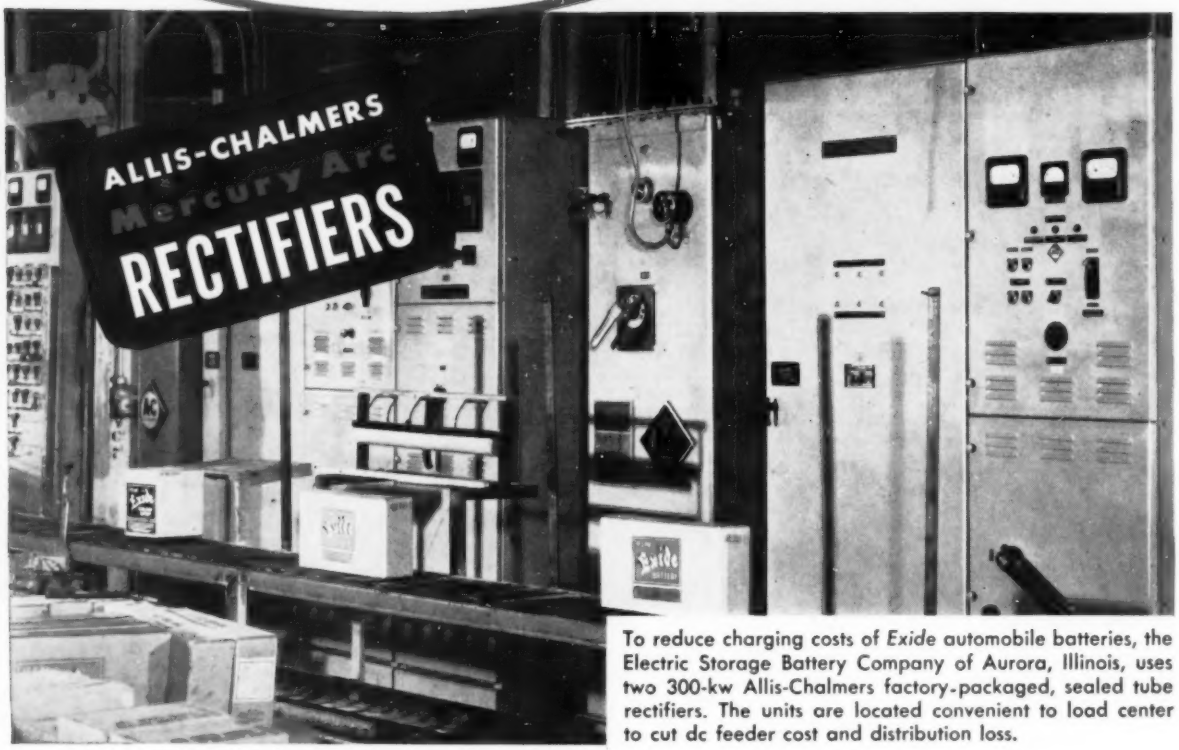
Close running clearances and double labyrinth seals between the shaft and outer bearing housings keep grease in the bearing and exclude dirt. Grease is kept out of the interior of the motor by a bearing cap with a long running clearance along the shaft. The cap is held tightly in place by hex head cap screws. Large grease chambers hold an ample supply of lubricant.

A-4363

ALLIS-CHALMERS

MILWAUKEE 1, WISCONSIN

Low Cost *Installation*



To reduce charging costs of *Exide* automobile batteries, the Electric Storage Battery Company of Aurora, Illinois, uses two 300-kw Allis-Chalmers factory-packaged, sealed tube rectifiers. The units are located convenient to load center to cut dc feeder cost and distribution loss.

FACTORY-PACKAGED RECTIFIER UNITS CUT INSTALLATION TIME AND COSTS

The factory-packaged design of Allis-Chalmers sealed tube mercury arc rectifiers has all component parts metal enclosed and integrally connected in one compact unit to cut labor time and costs . . . only connection to power and control leads and to cooling water supply is necessary to make unit ready for service. Because of their light weight, the rectifiers can be installed on a balcony or elsewhere, close to load centers to minimize direct-current feeder cost and reduce distribution loss . . . requires no special foundation.

Allis-Chalmers sealed tube rectifiers are offered in ratings from 220 kw at 250 volts to 1000 kw at 600 volts.

When you are planning new direct-current power installations of *any* size, compare the many cost cutting features of Allis-Chalmers mercury arc rectifiers. For complete details and engineering help, call your nearest A-C sales office or write Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4303

ALLIS-CHALMERS

Our Engineers Introduced Mercury Arc Rectifiers to U. S. Industry

This S-A 1412-foot conveyor at Chuquicamata's oxide plant has moved nearly 200,000,000 tons of crushed ore since 1926 without major replacements or repairs. The unique "tip-back" feature of these S-A "444" Carriers allows them to be inspected without shutting down the belt.

NEW CHUQUICAMATA SULFIDE PLANT

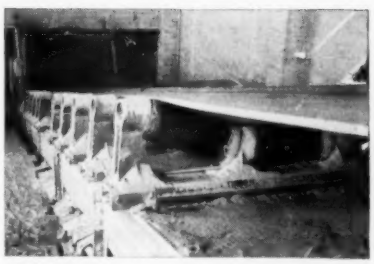
Handles 30,000 Tons of Ore A Day on S-A Belt Conveyors

The Chile Exploration Company's Chuquicamata plant has been called one of the largest and best engineered mining jobs in the world. An outstanding feature is the materials handling system.

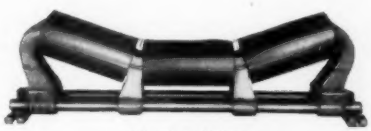
In planning this system, the company had the record of its older oxide plant to go by. Here more than 2500 S-A "444" heavy duty carriers have been in service for *over a quarter of a century.* All of the original S-A "444" carriers are in the multi-million ton class and are still on the job.

Because of this impressive performance, S-A "444" Carriers were specified for the miles of belt conveyors installed at the new Chuquicamata sulfide plant. While relatively expensive to begin with, their ability to take punishment year after year means lower handling cost per ton.

The same kind of performance that dictated Chuquicamata's choice of S-A Carriers is your assurance of lower costs, least maintenance and unfailing service when your belts travel on S-A Carriers. Write to have an S-A engineer call upon you —or send for our Carrier Bulletin No. 2-C.



These "Mammouth" carriers are probably the largest anti-friction units ever built. Equipped with double roller bearings they are designed to meet extremely rugged operating conditions.



"444" CARRIER

SINCE 1901 S-A STEPHENS-ADAMSON MFG CO

STEPHENS-ADAMSON MFG. CO.

5 Ridgeway Avenue, Aurora, Illinois • Los Angeles, Calif. • Belleville, Ontario

Engineering Division
Specialists in the design and manufacture of all types of bulk materials conveying systems.

Standard Products Division
A complete line of conveyor accessories including centrifugal loaders—car pullers—bin level controls—etc.

SealMaster Division
A complete line of industrial ball bearing units available in both standard and special housings.

The "inside" story of *ElectroniK* instruments

Maybe you've never seen what's inside the case of an *ElectroniK* instrument. And even if you have, you might not realize how each component has been painstakingly refined to contribute its share to the overall performance and dependability of the instrument. Three of these components in particular—the converter, "Continuous Balance" amplifier and the balancing motor—are key members of the *ElectroniK* team with which you should get acquainted.

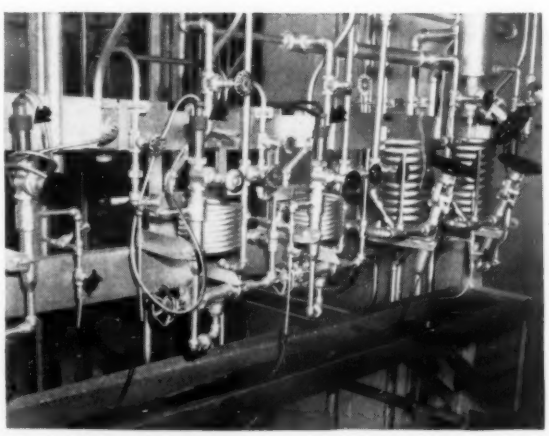
The Converter
is what transforms tiny direct-current signals from the thermocouple or other sensing element into an alternating voltage that the amplifier can conveniently handle. In principle, it is somewhat like the vibrator in your automobile radio. But because it deals with such small bits of electrical energy, it has been designed of carefully selected materials which prevent the introduction of misleading signals into the measuring system. It is hermetically sealed against the effects of dust, humidity and atmospheric pressure change, and is shielded against stray electrical and magnetic fields.

The "Continuous Balance Amplifier"
boosts the incoming signals by millions of times . . . makes them strong enough to operate the balancing motor. Although it looks like part of a radio chassis, few communications circuits could equal it for quality. It uses standard, easily obtained parts, which are operated far below their normal ratings to insure exceptionally long life. The circuit has great stability against drift and pick-up, and is thoroughly temperature compensated.

The Balancing Motor
does the work of moving the pointer, recording pen and any control devices that may be incorporated in the instrument. It packs plenty of power into a small space . . . gives ample torque to give fast, accurate positioning whenever the amplifier calls on it. Totally enclosed, the motor is impervious to dust, dirt and changes in mounting position.

in *Florida* too!

New Ebasco-built station utilizes *ElectroniK* instruments to



Conductivity cells, mounted in sampling lines, are connected to an ***ElectroniK*** *instrument on the central control board, to measure conductivity of condensate, saturated steam and evaporator distillate.*

The new Riviera station of Florida Power & Light Company, near West Palm Beach, features Ebasco's "outdoor" design. Inset shows a bird's eye view of four of the ***ElectroniK*** *instruments on the central control panel for one of the generating units.*

record vital operating data

As modern as tomorrow is the new 131,000-kilowatt Riviera Station of Florida Power & Light Company, which helps to serve the power needs of a fast-growing part of the state. Designed and built by Ebasco Services, Inc., this station features efficient, centralized control . . . in which *ElectroniK* instruments have important responsibilities.

The varied uses which *ElectroniK* instruments fill on this plant's control boards demonstrate the outstanding versatility of these instruments. One of the instruments, for example, helps to safeguard boilers and turbines by recording conductivity of steam and condensate at selected points. Another watches over critical temperatures in bearings, boilers, steam headers, circulating water and other vital spots in the heat cycle. And as an accurate guide to generator loading, other *ElectroniK* instruments provide a continuous record of stator and rotor temperatures.

Brown instruments offer wide coverage of many of the most important points of measurement in modern steam plants, including pressure gages in varied ranges . . . liquid level systems applicable to open and closed vessels . . . pH recording and controlling systems . . . flow meters . . . and a full selection of *ElectroniK* instruments for measurement of frequency, power, reactive power, voltage, current and for telemetering. Both pneumatic and electrical transmission systems are supplied for remote measurement in centralized control designs.

Your nearby Honeywell sales engineer is well qualified to discuss the requirements of your own plant . . . and he's as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, Wayne and Windrim Avenues, Philadelphia 44, Pa.

● **REFERENCE DATA:** Write for Bulletin 90-2, "Supervisory Instruments for Power Generation."

MINNEAPOLIS **Honeywell**

BROWN INSTRUMENTS

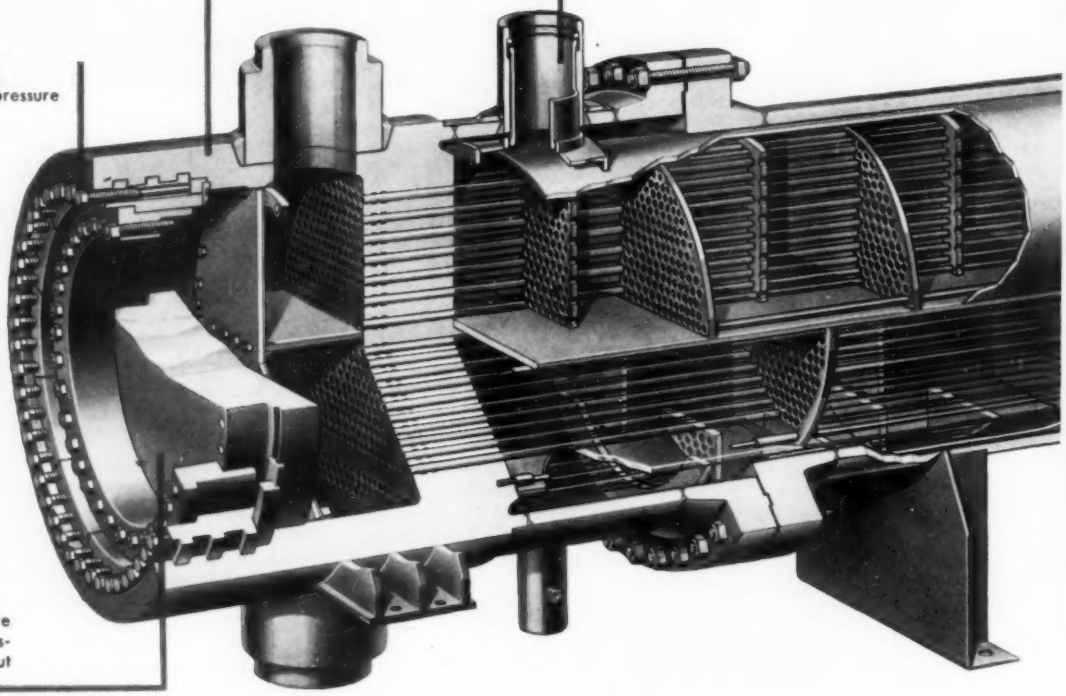
First in Controls

how the IMPROVED ALCO give you GREATER VALUE FOR

TYPE "D" HIGH-PRESSURE CLOSURE is simple, economical, highly effective. You can assemble and dismantle it with a minimum number of small tools. (Low-pressure closures also available.)

IMPROVED HIGH-TEMPERATURE STEAM INLET NOZZLE, plus excellent steam distribution to heat transfer surfaces, gives you increased operating efficiency.

SMALLER SCREW FASTENINGS allow easier bolting in high-pressure operation.



TYPE "D" CLOSURE COVERS are designed for easier, more economical maintenance. Gaskets can be replaced without removing covers.

when you buy the New Alco Feedwater Heaters

. . . You buy dependable, economical units, the result of more than 25 years experience in designing and building heat exchangers and other heavy-duty equipment for power plants of every size and description.

You buy rugged, highly efficient units that are . . .

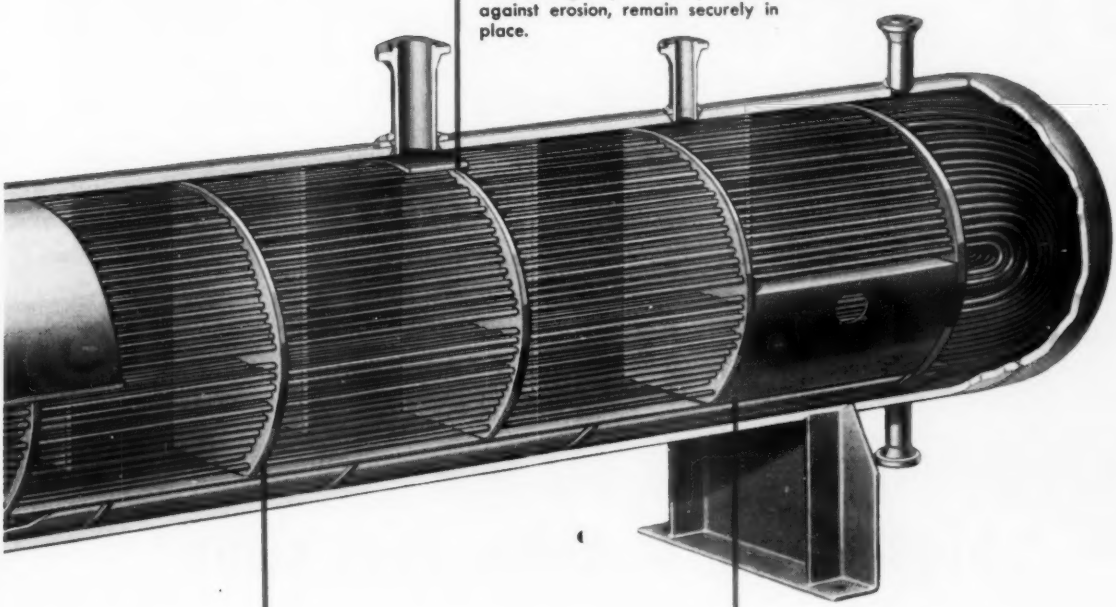
- custom-engineered to meet your own individual installation, operating and performance requirements.
- built to ASME code . . . with quality materials and under rigid shop inspection.
- designed to incorporate every one of the many special features required by increasing pressures and temperatures used in modern power plant practice.

Write or call your nearest Alco Products representative and ask him to give you the details. Ask him, too, about Alco Flextube Evaporators with patented Flextube descaling.

Find out in terms of your own specific needs how Alco Feedwater Heaters, along with Flextube Evaporators, give you *greater value for your equipment dollar.*

For your free copy of "Venting and Draining Feedwater Heaters and Evaporators," write to American Locomotive Company, Bldg., 143, Schenectady, N. Y.

FEEDWATER HEATERS
YOUR EQUIPMENT DOLLAR



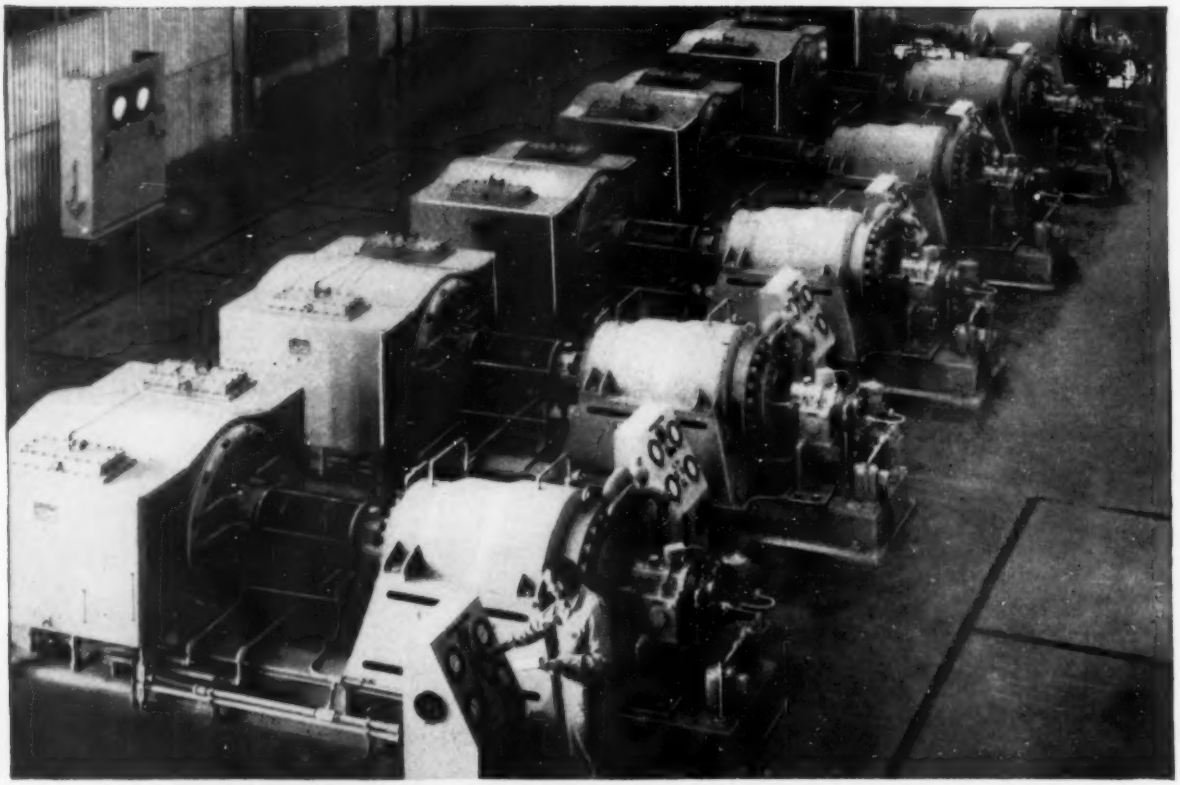
ALLOY STEEL IMPINGEMENT PLATES rigidly supported in tube-bundle structure—give you extra protection against erosion, remain securely in place.

SUPPORT PLATES are drilled and reamed for close fit, chamfered to prevent cutting of tubes. Result: less damage from vibration, longer tube life.

CAREFULLY PLACED AIR-WITHDRAWAL BOXES prevent air-binding — particularly important with low-pressure steam.

ALCO
PRODUCTS

AMERICAN LOCOMOTIVE COMPANY
Sales and Service Offices in Principal Cities



SIX WORTHINGTON HIGH-PRESSURE BOILER FEED PUMPS on the job at the Contra Costa Steam Plant of the Pacific Gas and Electric Company. Each pump delivers 500,000# per hour at a discharge pressure of 1,800 psig.

What should you look for in a high-pressure* boiler feed pump?

We think we're qualified to answer that. Back in 1923 we built our first high-pressure centrifugal boiler feed pump, and we've had a lot of experience making them since.

Here are some of the features you should look for:

All pressure joints should be *metal-to-metal ring type joints,* universally accepted as the proper construction for high-pressure service.

Inner assembly should be firmly anchored to the casing barrel at the inboard end, but *free to expand* under temperature changes at the outboard end without destroying perfect centering of running joints and bearing support.

Internal joints constructed so that hydraulic pressure acts to seal joints, rather than open them. Only in pumps of this design can the tightness of the internal joints be hydraulically tested during the process of assembly.

Pump casing made of forged steel, the same material that is selected for all high-pressure fittings and valves.

Centerline support of casing should allow for temperature changes with minimum distortion.

"Volute-passage" diffuser to eliminate narrow diffuser passages and a multitude of diffuser vanes.

All of these, by the way, are standard on Worthington high-pressure boiler feed pumps. And our customers are pretty happy about it, too.

Ask for our Bulletin W319B-1C. Write Worthington Corporation, Centrifugal Pump Division, Harrison, New Jersey. *Over 1300 psi C.3.12

WORTHINGTON

The World's Broadest Line Assures You the Right Centrifugal Pump for Every Job

Boiler Feed Normal Service • **Hotwell, Condensate, Chilled Water** • **Water Works, Circulation, Drainage, General** • **Boiler Feed High Pressure Service**

SECOND WORTHINGTON TURBINE GENERATOR installed at the Kohler Co. in Kohler, Wisconsin. Steam is extracted from this 6000-kw unit at the rate of 120,000 lb/hr. at 225 psi and 80,000 lb/hr. at 5 psi.

KOHLER OF KOHLER selects Worthington again

In 1949, Kohler of Kohler, manufacturers of plumbing fixtures, heating equipment, electric plants, air cooled engines and precision controls, installed their first Worthington turbine generator.

The 3000-kw Worthington unit operated in parallel with the outside power supply and delivered the rated kw load while automatically extracting 120,000 lbs. of steam per hour at 225 psi for heating and process work.

Because of the extremely economical and dependable operation of this machine, another Worthington turbine generator was the logical choice when power requirements increased. In November of 1952, a 6000-kw Worthington turbine generator was installed.

Now the two Worthington units furnish process steam for the plant and also supply a large part of their electrical requirements.

Follow the lead of Kohler and find out how Worthington turbine generators can pay off for you, too. Write to Worthington Corporation, Steam Turbine Division, Section T.4.5, Wellsville, New York.

T.4.5

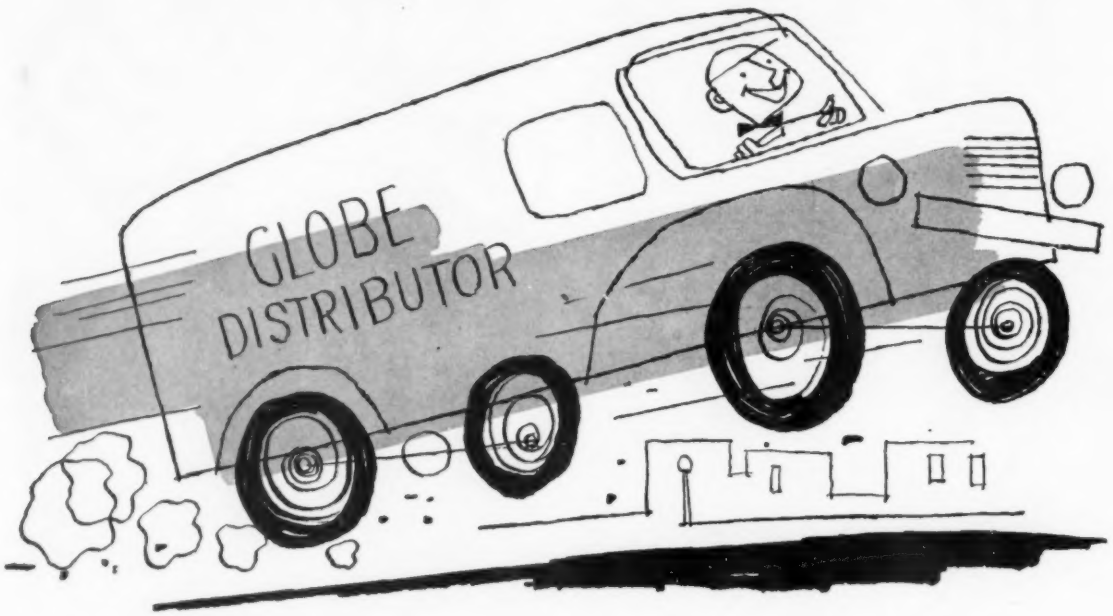
WORTHINGTON

STEAM TURBINES

Single- and Multi-Stage Turbines • Turbine-Generators • Deaerators • Boiler Feed Pumps • Surface Condensers

A GREAT TEAM IN STEAM

When you need welding fittings...



in a hurry... call your GLOBE distributor

Your Globe welding fittings distributor carries a wide variety of sizes and types in stock. As a result — he can supply you with the fittings you need . . . in a hurry

In fact, doing business with your Globe distributor is good business all around! His warehouse can be your warehouse . . . you won't have to be overloaded with a big inventory of welding fittings . . . you can reduce storeroom requirements and streamline your operations.

Make it a point to know your Globe distributor . . . a good man to deal with for all your welding fitting needs.

GLOBE STEEL TUBES Co., Milwaukee 46, Wis.

For the name of your Globe distributor, call any of these District Offices.

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Only Globe — among manufacturers of seamless Welding Fittings— produces its own seamless tubes. Only Globe offers you precision-processed fittings through every step of production — from billet to tube to fitting.

GLOBE
PRECISION PROCESS

SEAMLESS WELDING FITTINGS

GLOBE TUBES

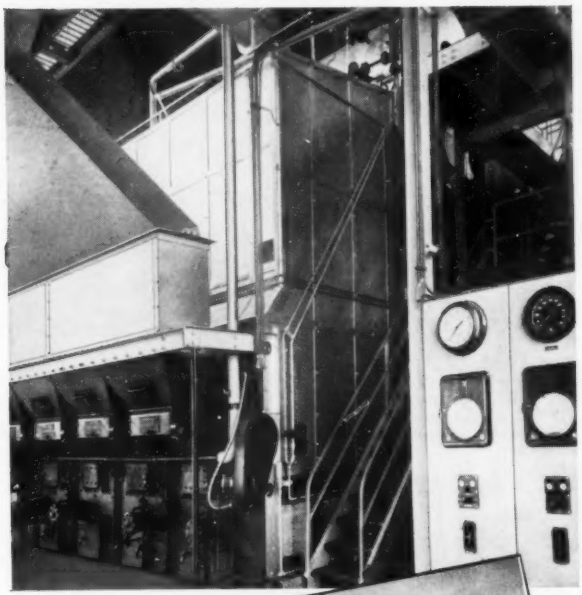
Producers of Globe seamless stainless steel tubes— Gloweld welded stainless steel tubes — alloy — carbon — seamless steel tubes — Globeiron (high purity Ingot iron) seamless tubes — Globe Welding Fittings

"HOW WE SAVE MORE THAN $90,000 A YEAR—

BY BURNING COAL THE MODERN WAY!"

says W. H. FISHER, Plant Engineer, Kerr Bleaching and Finishing Works, Concord, North Carolina.

"Powering our plant used to take nine boilers—now *one* does the same job *using 30% less fuel!* 6 firemen now do the work of 18—thanks to modern coal-handling equipment and automatic controls. That's why we say, you can't beat bituminous coal burned with modern equipment."



Above is a view of the plant's modern, space-saving coal-storage silo. To the left is a close-up of the firing aisle, showing the spreader stoker and the main control panel. Coal handling is automatic and dust-tight throughout. Automatic controls regulate firing, drafts and feed-water—give maximum efficiency at lowest cost.

If you operate your own steam plant, you can't afford to ignore these few down-to-earth facts!

COAL in most places is today's lowest-cost fuel.

COAL resources in America are adequate for all needs—for hundreds of years to come.

COAL production in the U. S. A. is highly mechanized and by far the most efficient in the world.

COAL prices will therefore remain the most stable of all fuels.

COAL is the safest fuel to store and use.

COAL is the fuel that industry counts on more and more—for with modern combustion and handling equipment, the inherent advantages of well-prepared coal net even bigger savings.

Burning coal the modern way can save *you* money, too! First, labor costs can be cut to a minimum with up-to-date coal- and ash-handling equipment. On top of that, today's combustion installations give you 10 to 40% more power from each ton of coal than was possible a few years ago!

If you're planning to modernize, or if you're building a new plant, call in a consulting engineer. He'll show you how you can get big savings by burning coal in a modern plant designed to meet your *specific* needs.

America's coal reserves are virtually inexhaustible; America's coal industry is the world's most productive and efficient. That's why coal has a future dependability of supply that no other fuel can offer. That's why, of all fuels, the price of coal is most likely to remain stable.

BITUMINOUS COAL INSTITUTE

A Department of National Coal Association, Washington, D. C.

FOR HIGH EFFICIENCY FOR LOW COST

YOU CAN COUNT ON COAL!

AN *Exclusive* ERIE CITY DESIGN

The **VL** with EXCLUSIVE features guarantees a minimum of furnace maintenance and insures a positive supply of clean water to the water walls. These EXCLUSIVE features are the result of many years of experience in building two drum boilers; thousands of which are operating in the field today, giving users the satisfactory service they demand.

We Pay Royalties to No One for These Designs

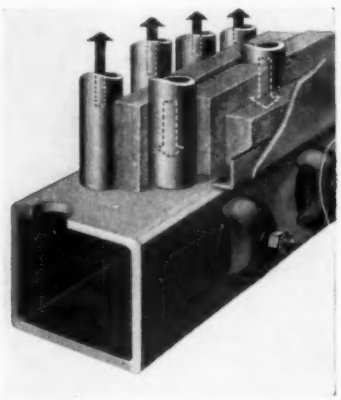
COMPARE THESE *Exclusive* FEATURES

RING-FLOW CIRCULATION IN EACH WATER WALL ELEMENT

For each pair of inside steam tubes, there is a water circulating tube which feeds **clean** water from the top drum to bottom water wall headers. Dividing insulation keeps water circulating tubes cool while heat is carried away from refractory by the steam generating tubes, assuring ring-flow circulation in each element.

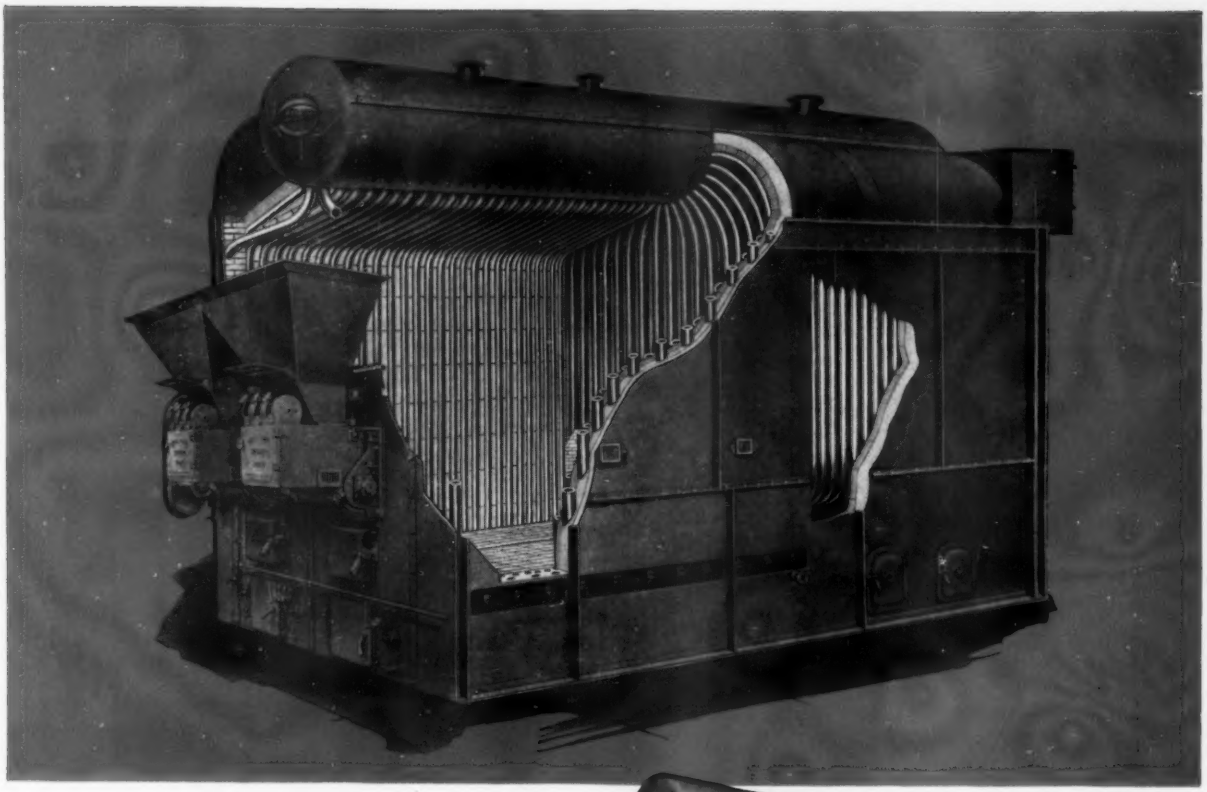
POSITIVE WATER SUPPLY TO WATER WALLS

Normal water level is at the middle of the top drum, but to **assure positive water supply** to bottom headers, under any abnormal conditions, we locate a pair of front feeder tubes at lowest point in the top drum.



WATER WALLS ACCESSIBLE FROM OUTSIDE THE SETTING

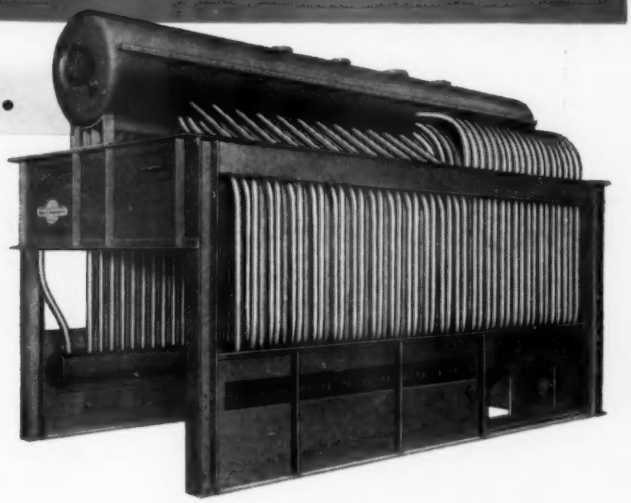
No need to go into the furnace to inspect the water wall headers —VL's are equipped with large handhole openings, **located outside the setting,** for access to any part of the header. No elaborate tools required to remove handhole plates. View above also shows how each downcomer tube supplies a pair of steam or riser tubes in side water wall element.



WITH THE FIELD ....

LOW FURNACE ROOF PROTECTS BOILER TUBES

Furnace tubes entering low on the drum **protect drum shell** and top ends of boiler tubes from radiant heat absorption in the event of water low in the gauge.



The VL's integral water wall design with large water and steam capacity combine to make this steam generator universally accepted for its good performance, low maintenance, and ready adaptability to any firing method. Catalog SB-43 gives a detailed description and dimensional data on the Erie City VL Steam Generator.

ERIE CITY
114 Years in Steam Generation

You can depend on Erie City for sound engineering

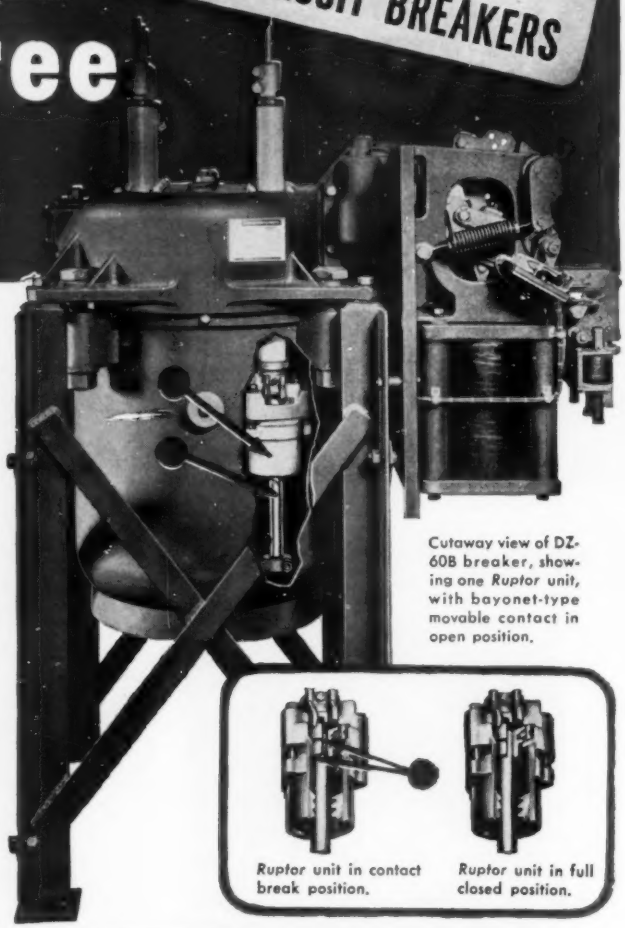
ERIE CITY IRON WORKS • *Erie, Pa.*

STEAM GENERATORS • SUPERHEATERS • ECONOMIZERS • AIR PREHEATERS
UNDERFEED AND SPREADER STOKERS • PULVERIZERS

Three Reasons Why

...Years of Trouble-Free Service

ALLIS-CHALMERS *Indoor* OIL CIRCUIT BREAKERS



Cutaway view of DZ-60B breaker, showing one *Ruptor* unit, with bayonet-type movable contact in open position.

Ruptor unit in contact break position.

Ruptor unit in full closed position.

One **Few moving parts!**

Bayonet contacts (1) are the only moving parts of the *Ruptor* interrupting device.

Two **Easy inspection!**

Drop the tank, and the bayonet contacts are visible in open position. For access to the stationary contacts, one needs only to remove four bolts and cylindrical shell (2).

Three **Self-aligning and Self-cleaning contacts!**

Tulip and bayonet contacts (3) maintain high conductivity without readjustment or cleaning. Arc energy is minimized by efficient interruption within oil-filled *Ruptor* unit. This in turn contributes to long contact life and low oil deterioration.

In addition, a mechanically trip-free solenoid operating mechanism controls contacts of time-proved *Ruptor* interrupting devices And pole unit mechanism is self-lubricated — completely enclosed — sealed from dust, dirt, corrosion.

In brief, Allis-Chalmers DZ breakers are built to assure years of dependable, trouble-free service.

Allis-Chalmers power circuit breakers are available in ratings from 2.5 to 230 kv, with interrupting capacities from 15,000 to 10,000,000 kva, to meet all industrial and power company requirements. For more information, call your nearby A-C representative, or write to Allis-Chalmers, Milwaukee 1, Wisconsin.

A-4057

Ruptor is an Allis-Chalmers trademark.

TYPE	RATED KV	MINIMUM KV AT RATED KVA	RATED AMPS	KVA INT. CAPACITY
DZ-40B*	7.2	2.3	600	100,000
			1200	100,000
			2000	100,000
DZ-60B†	13.8	4.0	600	150,000
			1200	150,000
DZ-100B†	13.8	4.0	1200	250,000
DZ-200B†	13.8	6.6	1200	500,000
			2000	500,000

*Ask for Bulletin 71B6179. †Ask for Bulletin 71B6129.

ALLIS-CHALMERS

24 ACRES *Cover the World*

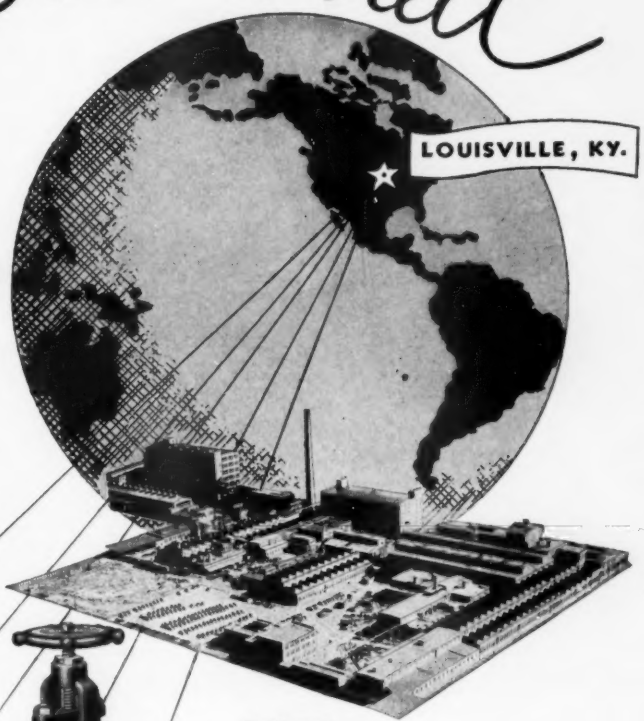
. . . with TOP QUALITY

DROP FORGED STEEL

VALVES, FITTINGS and FLANGES

by

Vogt



Air View of
Henry Vogt Machine Co.

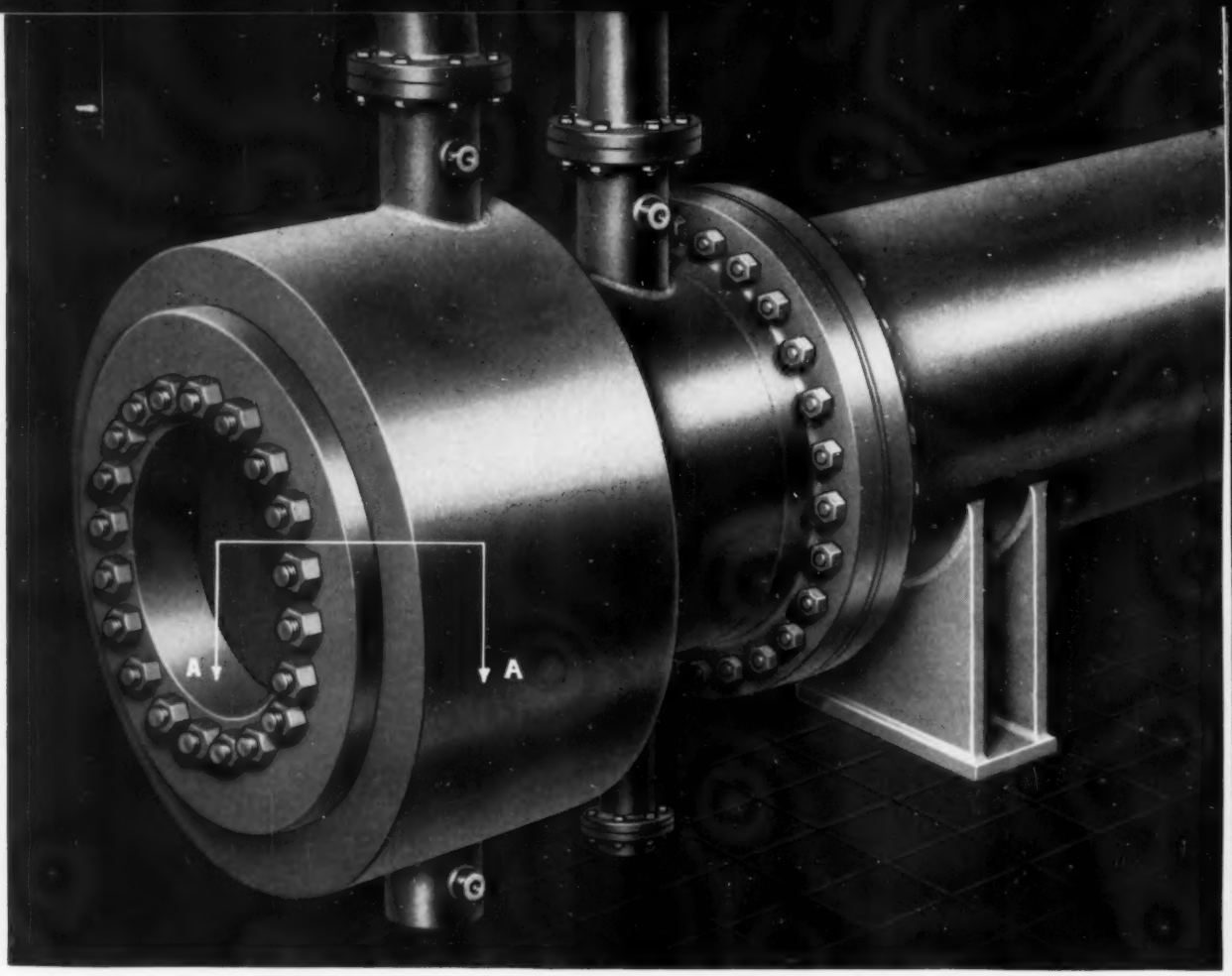
This 24 acre Vogt plant supplies the most comprehensive line of top quality *drop forged* steel piping materials anywhere available to industry. That's why they're the choice of leading refineries, power plants, chemical plants, etc., the world around!

OUR COMPLETE LINE INCLUDES

Flanged, Screwed and Socket Weld End Globe, Gate and Check Valves • Ells, Tees and Crosses • Couplings • Bushings • Plugs • Unions • Flanges and Flange Unions • Welding Heads

HENRY VOGT MACHINE CO. LOUISVILLE 10, KY.

Branch Offices: New York, Philadelphia, Chicago, Cleveland, St. Louis, Dallas, Charleston, W. Va.



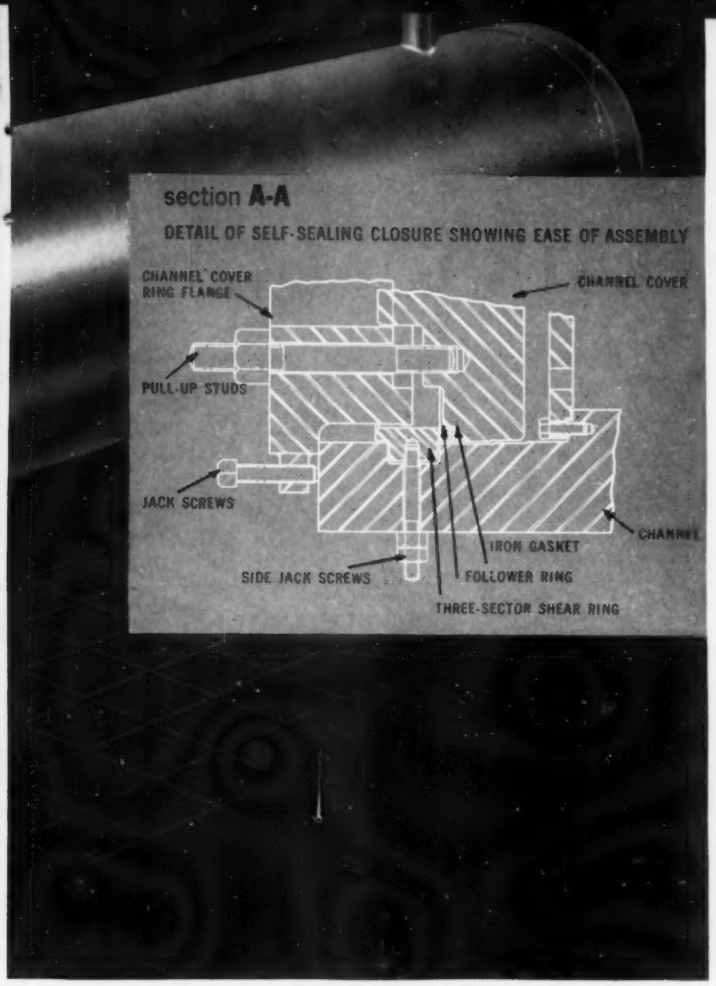
A.O.Smith Feed Water Heaters selected for one of newest Midwest high-efficiency power plants

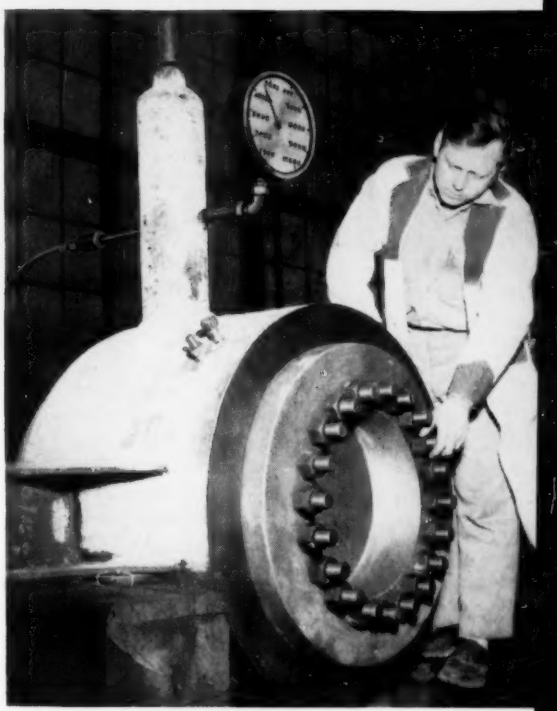
Six high-pressure Feed Water Heaters, designed with desuperheating and drain cooling sections, were built, installed and are on stream in this new 1800-psi steam power plant on the shore of Lake Michigan.

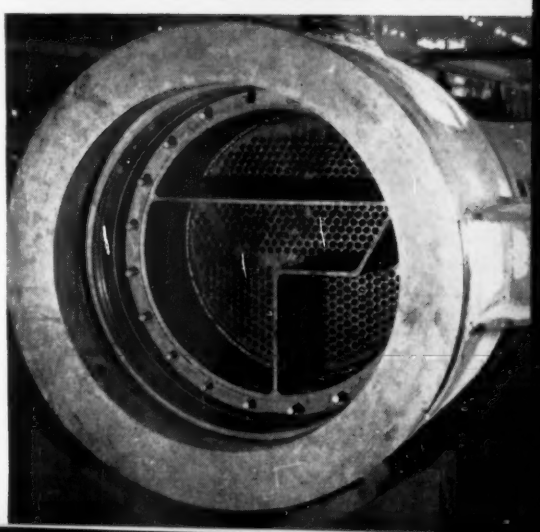
In performance, they fully justify their selection for this demanding service. We are now manufacturing an order for six more identical units for a duplicate addition to this plant.

Since specifications of 1,000 to 10,000 psi are run-of-mill in our vessel and exchanger shops, we are uniquely fitted and equipped to satisfy the current requirements of power-plant designers.

We invite you to bring your heat exchanger problems to A. O. Smith. You'll profit from the services of one of the finest thermal design groups in this country.







top right: Three of the six high-pressure feed water heaters undergo final inspection before shipment for installation in the new power plant. They are designed for 2400 psi on the tube side.

right: Testing the end closure and channel of one of the feed water heaters at 4800 psi. The closure is self-sealing.

bottom: View of interior of channel shows tube sheet, pass plates and recess for shear ring of self-sealing closure.

Through research A.O. Smith *... a better way*

A.O.Smith
CORPORATION

Process Equipment Division
Milwaukee 1, Wisconsin

International Division: Milwaukee 1

68 units to serve
JOPPA STEAM-ELECTRIC STATION

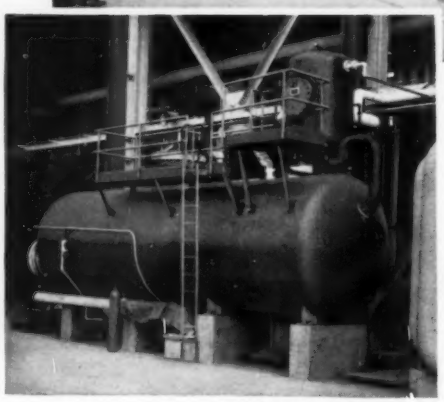
Feedwater installation by Foster Wheeler includes 12 high-pressure heaters, 34 low-pressure heaters, 18 cooling water exchangers (including make-up heaters) and 4 evaporators.

Constructed by Electric Energy, Inc. to supply approximately half of the power for AEC's Paducah Area Project, the Joppa Steam-Electric Station is designed for 937,500 KW in six boiler and turbine units. Of the semi-outdoor type, it represents one of the largest electric power stations ever planned for one building operation.

Few installations require the number of heaters which this new station will have when completed; probably none can boast of larger high-pressure heaters. The six crossover high-pressure heaters each have a surface of 7,760 sq ft capable of heating 1,162,700 lb of feedwater per hr from 411.1 F. to 470.4 when supplied with steam at a pressure of 497 psia, total temperature of 721.1 F. The six 10th-stage high-pressure heaters each have 4,858 sq ft surface. Each set is equipped with desuperheating, condensing and drain-cooling sections, and is built for handling 3200 psi, 500 F water.

The closure for these high-pressure heaters incorporates the well-known "Lockhead" feature. A patented Foster Wheeler construction, this closure provides a means for supporting the head pressure load that is separate from that for supporting the gasket compression load. Foster Wheeler Corporation, 165 Broadway, New York 6, N. Y.

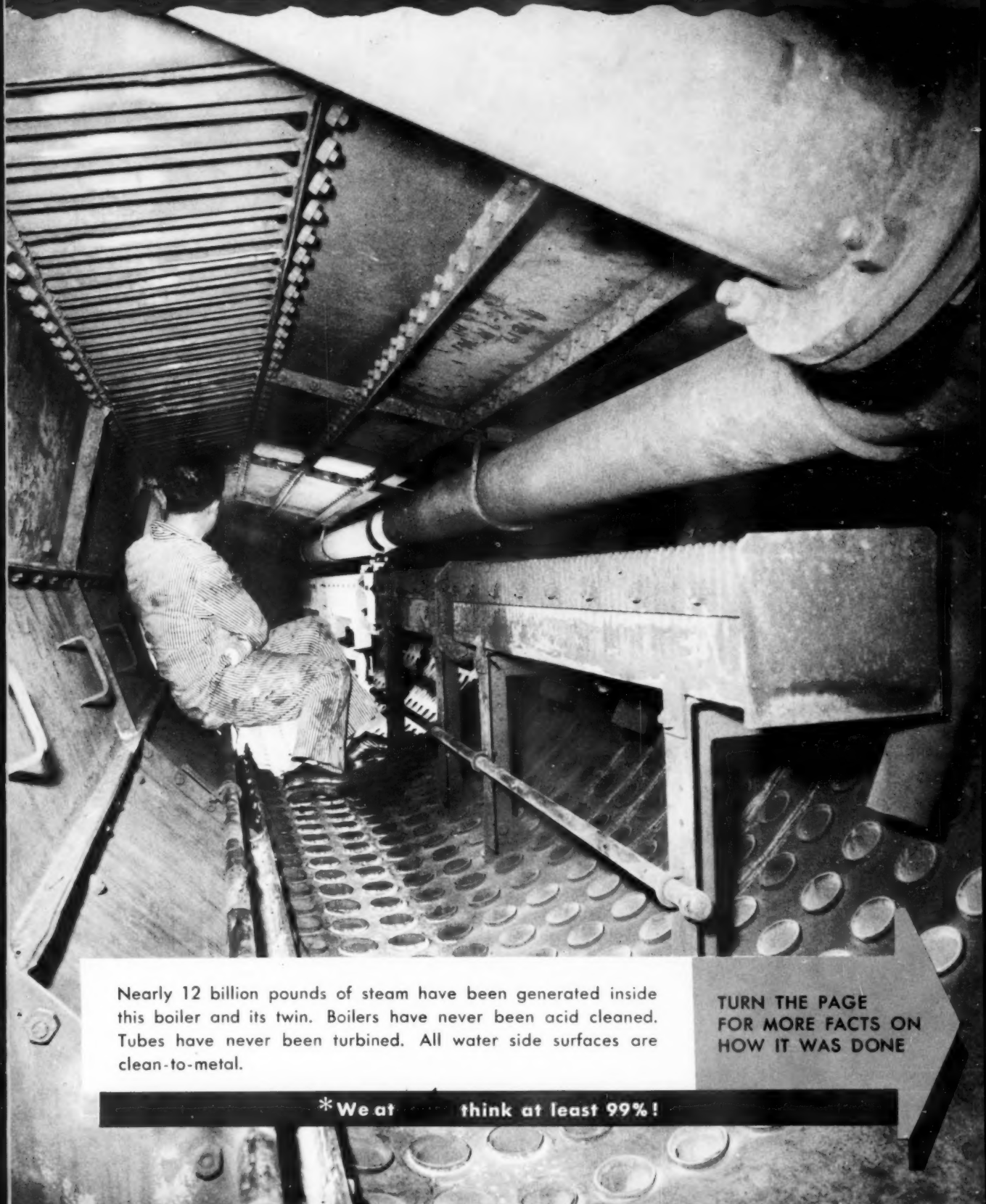
▲ Crossover and 10th-stage feedwater heaters. Crossover heater is approximately 38' high. Shell design pressure is 550 psi at 800 F; tube design pressure 3200 psi at 500 F.



◀ Foster Wheeler evaporator with deaerating preheater. Total heating surface 3450 sq ft capable of evaporating 30,000 lbs net vapor per hr.

FOSTER WHEELER

Proof of PERFECT* Water Treatment PERFORMANCE



Nearly 12 billion pounds of steam have been generated inside this boiler and its twin. Boilers have never been acid cleaned. Tubes have never been turbined. All water side surfaces are clean-to-metal.

TURN THE PAGE FOR MORE FACTS ON HOW IT WAS DONE

*We at think at least 99%!

BOILER OPERATING DATA

● Two new boilers were put on line in a Southwestern municipal utility plant at the same time late in 1949. Rated capacity of each unit is 250,000 pounds of steam per hour at 950 p.s.i. Normal operating rates range from 150,000 to 175,000 pounds of steam per hour per unit.

The Nalco System of water treatment has been used continuously in these boilers. Raw water softening is by Nalcite* Ion Exchange Resins, and other Nalco products are used for after-treatment, internal treatment, and condensate return line protection. Results have been perfect. Boilers have never been turbined or acid cleaned, and are opened only for annual internal inspection.

**Registered Trademark*

CLEAN . . . FOR TOP HEAT TRANSFER EFFICIENCY
What appear to be chalk marks in this unretouched photo are scrape marks which indicate only the usual powdery film left on the metal when the boiler is drained.

AND THE MUD DRUM IS SPOTLESS, TOO!
Another unretouched photo inside the mud drum of one of the boilers shows the like-new condition after years of service. No deposits or corrosion of any kind have been found in tubes or drums.

Nalco ON THE JOB

● Results like these are encountered every day in plants when the complete Nalco System of water treatment is on the job. The Nalco System is adaptable to old and new plants of any capacity, temperature, or pressure. Whether you operate a public utility or a space heating boiler, you will find your Nalco Representative of real assistance in the solution of your water treatment problems. Call him today, or write for full information.

NATIONAL ALUMINATE CORPORATION
6216 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

THE *Nalco*® SYSTEM . . . Serving Industry through Practical Applied Science

Another great Detroit Stoker.....

MOST IMPORTANT DEVELOPMENT IN COAL BURNING SINCE INTRODUCTION OF THE DETROIT ROTOGRATE

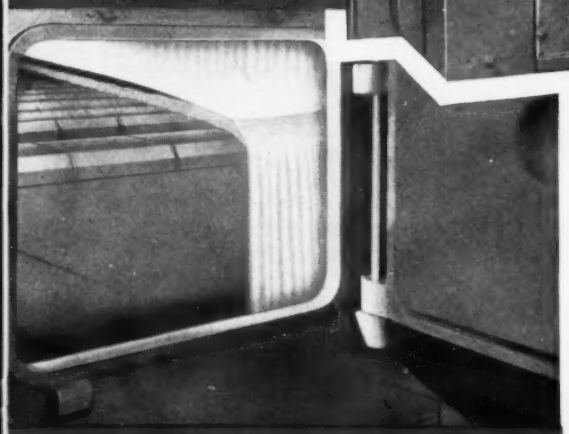
Detroit RotoStoker Type C-C

(CONTINUOUS CLEANING)

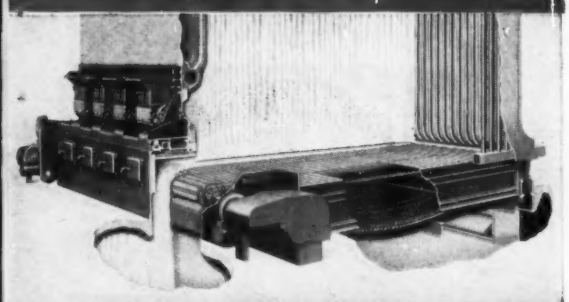
Detroit RotoStoker Type C-C discharges ash continuously at the front.

Detroit RotoStoker Type C-C (Continuous Cleaning)

DETROIT ROTOSTOKER TYPE C-C



Detroit RotoGrate Stoker—Traveling Grate Spreader Stoker



Users of medium and small size steam generators may now have the long proven advantages of continuous ash discharge spreader stoker firing with the Detroit RotoStoker Type C-C.

CHECK THESE ADVANTAGES:

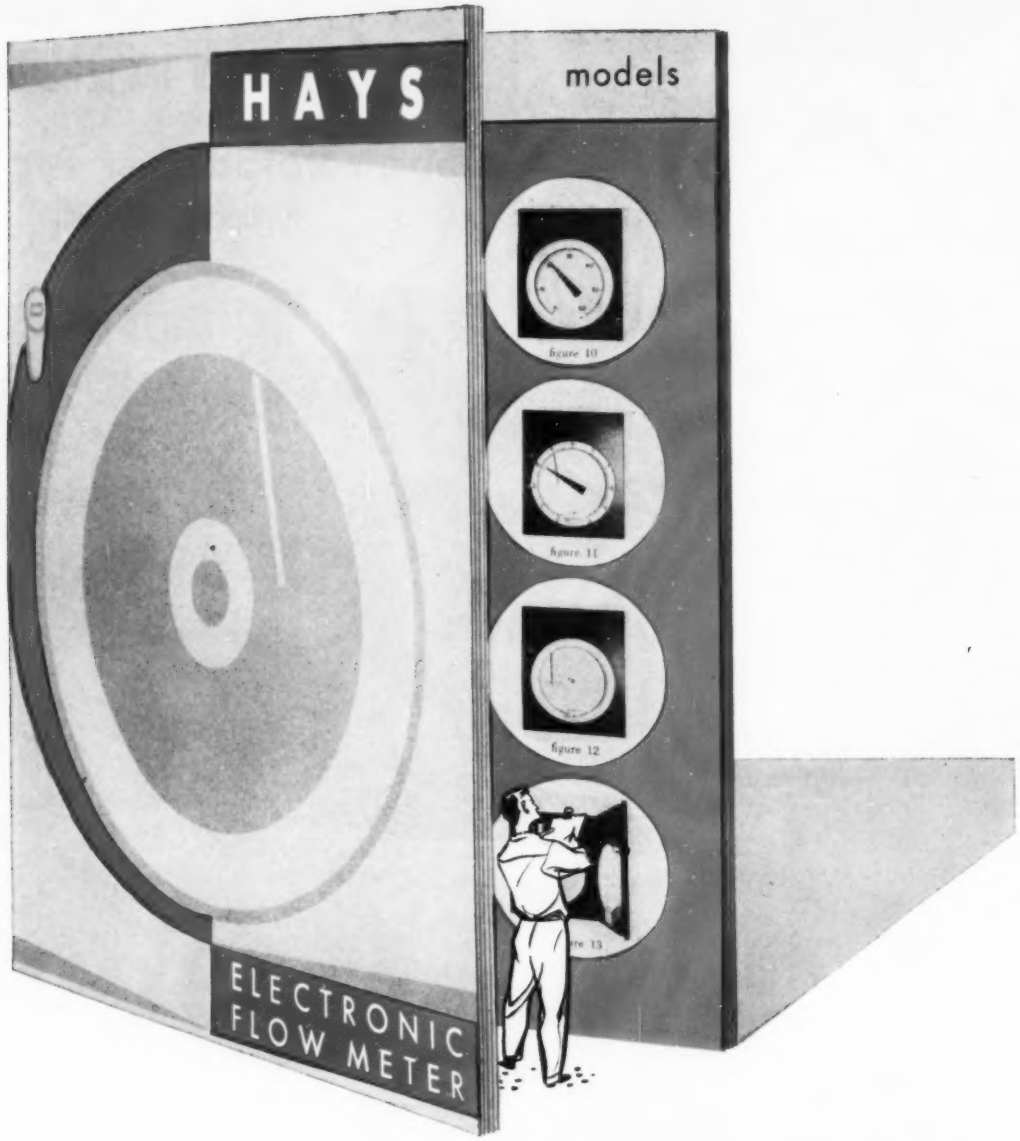
- Cleans Fuel Bed and Discharges Ash Continuously at the front.
- Smokeless Operation Through a Wide Load Range
- Efficiently Burns Bituminous Coals and Lignite.
- Insures Continuous Uninterrupted Steaming Capacity and High Availability.
- Responds quickly to Fluctuating Loads
- Fuel Feeders Handle High Moisture Coals Easily and Without Clogging
- Operation Automatic and Dependable
- Easily Applied to Existing Boilers—No Basement Necessary
- Design results in Low Maintenance
- Many Sizes Available to Develop from Approximately 5,000 to 75,000 Pounds of Steam Per Hour

For large steam generators Detroit RotoGrate Stokers have proven their merit for more than fifteen years. The *first* and *foremost* traveling grate spreader stoker, the Detroit RotoGrate Stoker was first to establish the tremendous advantages of continuous ash discharge, spreader stoker firing.

DETROIT STOKER COMPANY

GENERAL MOTORS BLDG., DETROIT 2, MICH.

Works at Monroe, Mich. • District Offices in Principal Cities



A guide to better flow metering

Here's a new fact-filled, technical booklet that tells you feature for feature how the new Hays electronic flow meter excels.

Electronic operation—provides maximum accuracy (¼% of full scale differential), and speed (4 seconds for full scale pen travel).

Mercuryless transmitters—rupture-proof metallic bellows for differential pressure measurement.

Continuous integration—motor-driven, continuous mechanical integrator is extremely accurate even on rapid load changes.

Other features include powerful motor, easy readability, accuracy unaffected by normal temperature changes, optional explosion and weather-proof transmitter.

Write for bulletin 54-1074-222 and get the important facts.

Automatic Combustion Control
Boiler Panels • CO_2 Recorders
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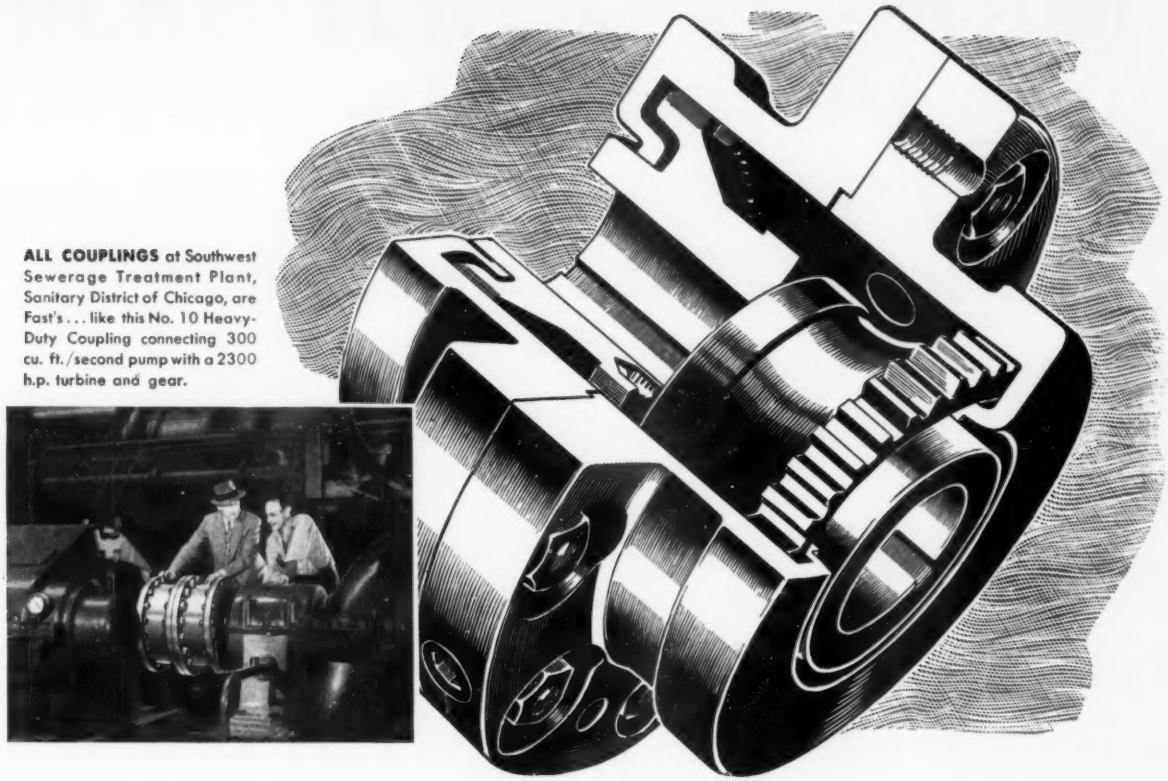
THE hays CORPORATION

MICHIGAN CITY 3, INDIANA



ALL COUPLINGS at Southwest Sewerage Treatment Plant, Sanitary District of Chicago, are Fast's . . . like this No. 10 Heavy-Duty Coupling connecting 300 cu. ft./second pump with a 2300 h.p. turbine and gear.

For free engineering service that saves dollars and down-time . . .

FAST'S Couplings are FIRST!

When you specify Fast's Couplings, you get the benefit of Koppers *free engineering service* . . . your assurance of the right coupling for any job and the right solutions to tough coupling problems.

FOR EXAMPLE: "Get the drawings and send them down to Koppers" is the standard answer in one plant whenever a tough coupling application arises!

FOR EXAMPLE: After studying a list of spares for stand-by units made up by one customer, a Koppers sales engineer eliminated duplications . . . resulting in a smaller order for him but a *much smaller inventory* for the customer!

Add the *rugged construction* of Fast's Couplings . . . with their original design maintained without basic change or sacrifice in size or materials. Add their lowest cost per year . . . their life expectancy guarantee. *Fast's usually outlast the equipment they connect.* Result: it will pay you to write today for full details on how Fast's Couplings and Koppers Engineering Service can help you get uninterrupted power transmission! Send for free catalog to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* 227 Scott Street, Baltimore 3, Md.

KOPPERS®

THE ORIGINAL

FAST'S Couplings

METAL PRODUCTS DIVISION • KOPPERS COMPANY, INC. • BALTIMORE, MD. This Koppers Division also supplies industry with American Hammered Industrial Piston and Sealing Rings, Koppers-Elex Electrostatic Precipitators, Aeromaster Fans and Gas Apparatus.

Engineered Products Sold with *Service*

KOPPERS COMPANY, INC., *Fast's Coupling Dept.,* **227 Scott St., Baltimore 3, Md.**

Gentlemen: Send me a Fast's Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.

Name .....

Company .....

Address .....

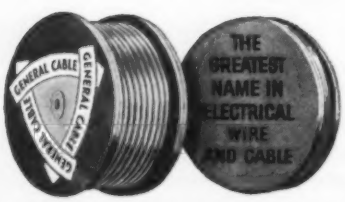
City ..... Zone ..... State .....

THE GREATEST NAME IN ELECTRICAL WIRE AND CABLE

SAFETY M.I. WIRING SYSTEM

PERMANENT | FLEXIBLE | RUGGED | MOISTUREPROOF | RESISTS HEAT | SMALL DIAMETER SAVES SPACE

THE WORLD'S NEWEST, MOST VERSATILE ELECTRICAL WIRING!



BARE, WEATHERPROOF, INSULATED WIRES and CABLES FOR EVERY ELECTRICAL PURPOSE

1953 Code Approved for wiring jobs up to 600 volts, Safety m.i. Wiring has proved its versatility for power, lighting and control. In power plants, industrial and commercial buildings, processing plants, ships and in dozens of other applications where deterioration is a major problem.

By acting as its own conduit... by unique flexibility and small diameter... Safety m.i. Wiring has further proved its ability to provide lower installed costs. For information on this amazing product, check General Cable today.

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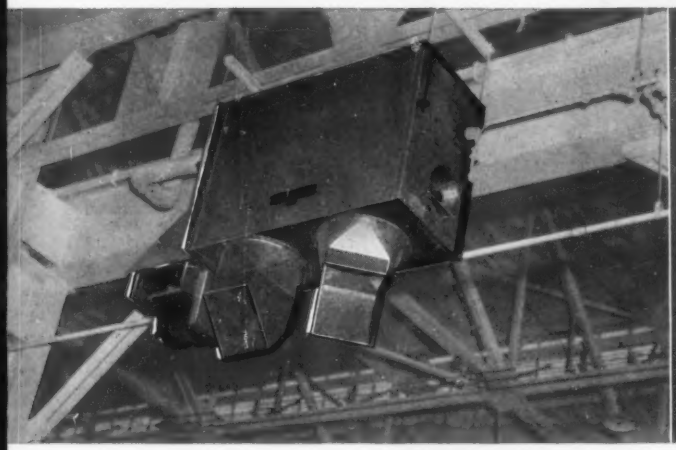
HEAT–VENTILATE YOUR PLANT

WITH THESE SPACE-SAVER "BUFFALO" UNITS!



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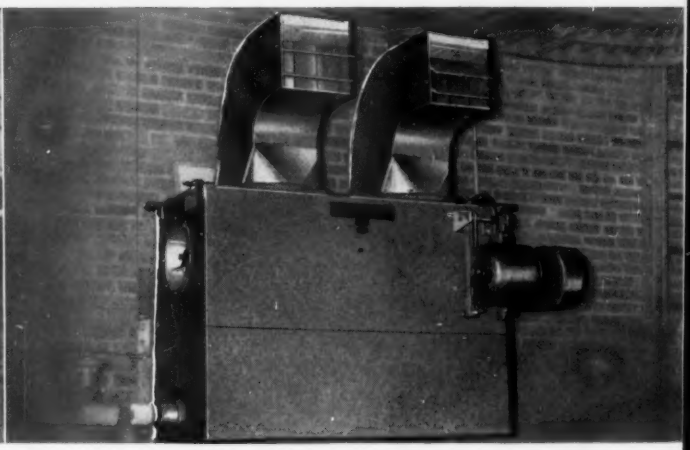
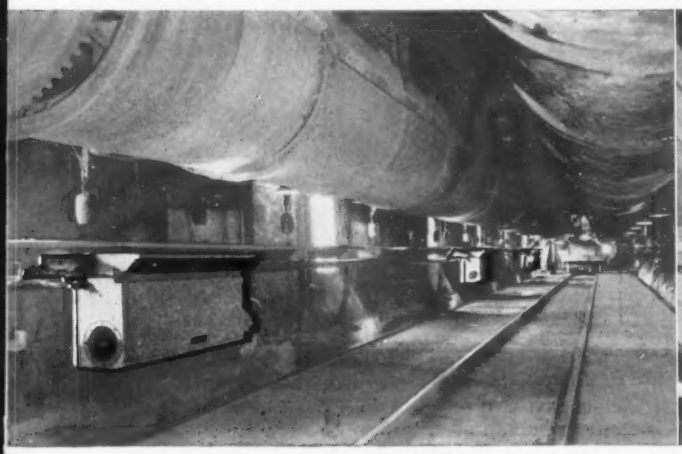
with a "Buffalo" Suspended Lowboy Unit Heater. Easily mounted in roof trusses. Spreads abundant, low-cost heat where you need it. Provides ventilation in warm weather.



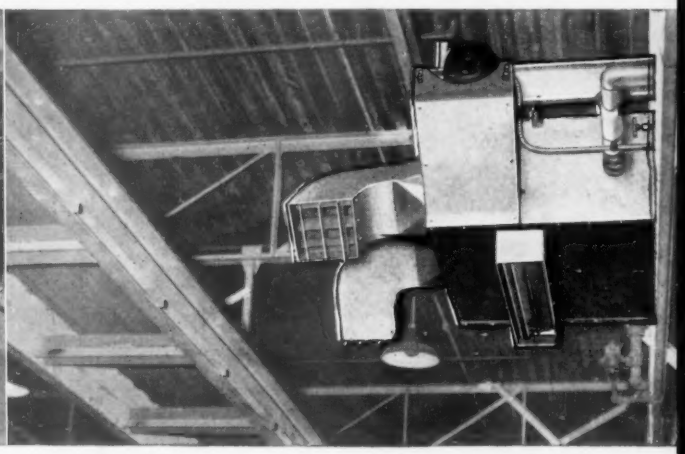
FRESH, CLEAN WARM AIR

(or cool outside air) is delivered by a compact "Buffalo" Highboy Unit with fresh air filtered intake thru side wall. Bearing bowl at left permits easy external lubrication.



LOW OVERHEAD – HIGH EFFICIENCY!

Wall-mounted Lowboys provide plenty of heat even where quarters are cramped. New coil design increases heating surface, with narrower coil section. Coils are non-freeze.

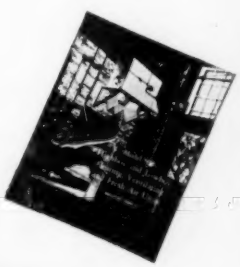


SWIVEL OUTLETS "AIM" FLOW

accurately — a "Buffalo" efficiency feature. Others are "Buffalo" mixed-flow fans with unusually stable performance — standardized parts — lifetime construction.

Let us show you NOW how low-cost and easy it is

to heat and ventilate your plant. Bulletin 3704-A gives all details on the units to handle your heating — ventilating — makeup air problem. Handy chart gives you air diffusion distances for each unit and capacity up to 35,000 cfm.



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"Buffalo"

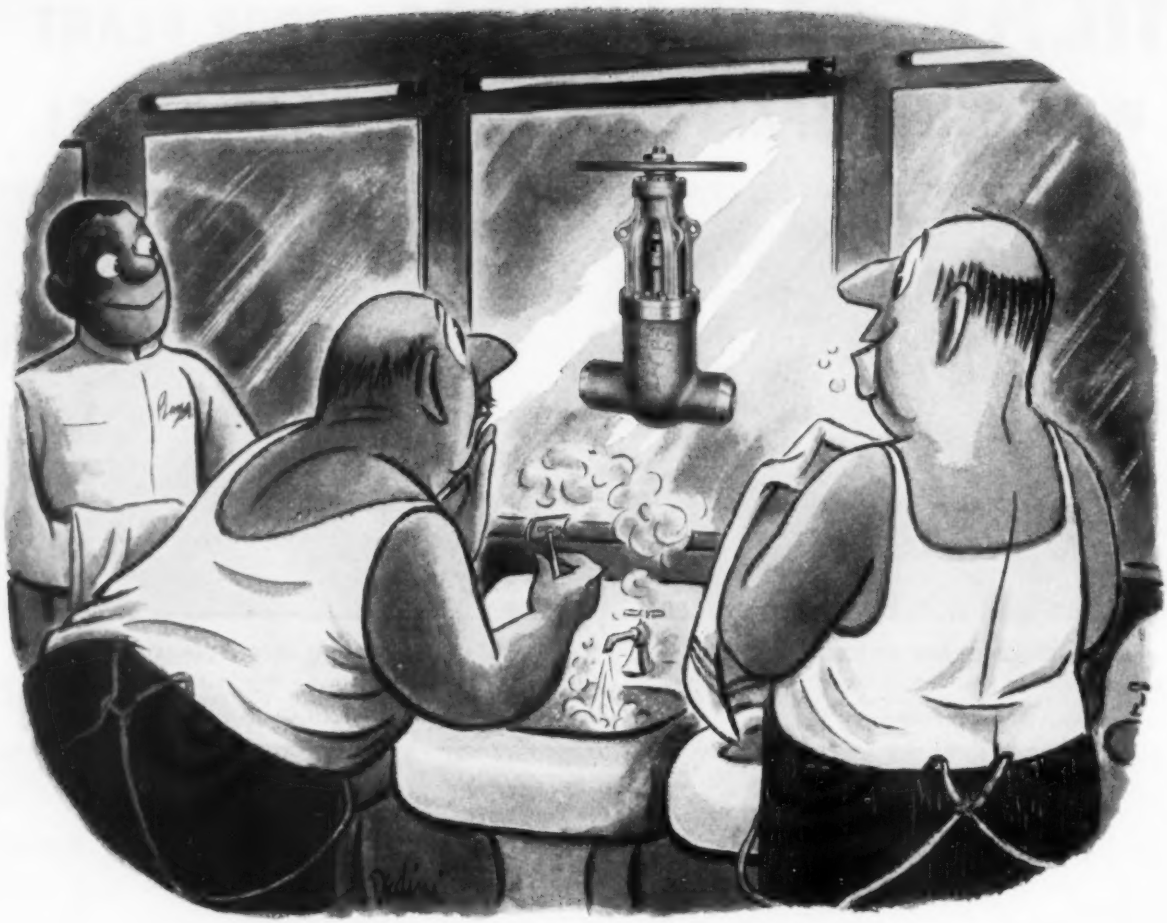
BUFFALO FORGE COMPANY

488 BROADWAY BUFFALO, NEW YORK

PUBLISHERS OF "FAN ENGINEERING" HANDBOOK

Canadian Blower & Forge Co., Ltd., Kitchener, Ont.
Sales Representatives in all Principal Cities

PRESSURE BLOWING COOLING HEATING FORCED DRAFT VENTILATING AIR CLEANING AIR TEMPERING INDUCED DRAFT EXHAUSTING



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Naturally! Since Powell makes more kinds of valves—and has probably solved more valve problems—than any other organization in the world. And Powell Valves have a record of dependable flow control since 1846.

Just name the kind of precision valve you need—Powell can supply it. Made ⅛" to 30" and 125 pounds to 2500 pounds W.S.P. Bronze, iron, steel and corrosion resistant alloys. Available through distributors in principal cities. On problems, write direct to The Wm. Powell Company, Cincinnati 22, Ohio.

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Powell Valves

108th year

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BIG TRUTH
about boilers

Out of 86 years of experience in designing and building quality steam generating equipment comes one of the most revealing reports ever written on boilers. We at Kewanee make that statement because these findings are based on fact and truth . . . on careful search and engineering exploration. In it we present:

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Here you will discover a way to judge boilers so you can be sure of the lowest operating cost—highest efficiency—greatest dependability—maximum flexibility—longer boiler life. You will learn how to eliminate confusion in considering boilers . . . know how to compare like examples and not be misled by vague technical claims. You can be SURE you have made the best buy when you know the BIG TRUTH about boilers . . . and you will choose Kewanee boilers because you know you will save on fuel—get greater efficiency—cut repair bills.

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REPORT **TELLS ALL . . .**

How to cut fuel costs.

Data on "cruising speed" savings.

Facts on "nominal capacity" operation.

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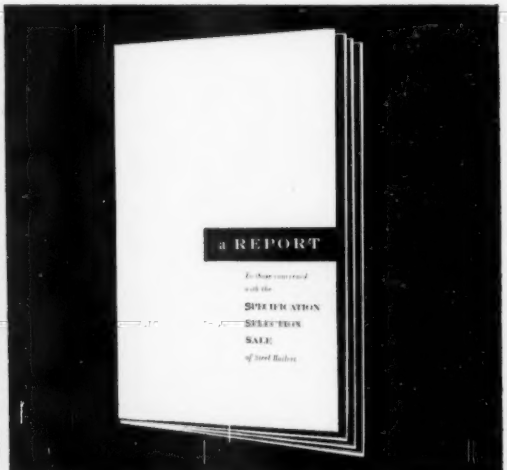

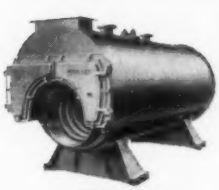

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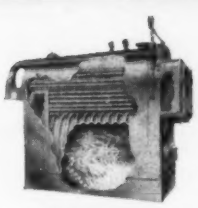

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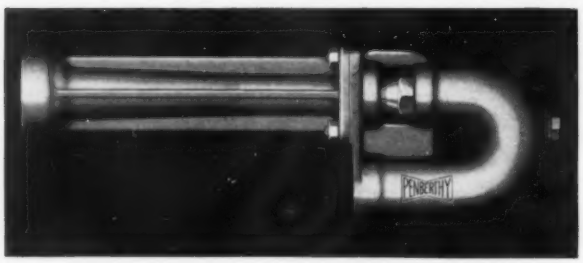

JET PUMPS—Penberthy can help you put the simple, economical principles of the jet pump to work wherever it's necessary to transfer or mix any liquid which will flow through a pipe. We make a complete line and have years of engineering experience upon which you can depend.

AUTOMATIC INJECTORS

Penberthy injectors are the accepted method of assuring a dependable supply of feed water, at lowest cost, to oil field and other firebox and portable boilers. They are being used increasingly for standby service on many large boilers. Easily installed, they require little or no attention.

AUTOMATIC CELLAR DRAINERS • WATER HEATERS EJECTORS • HYDRAULIC EJECTORS • EDUCTORS EXHAUSTERS • CYCLING JET PUMPS • SYPHONS

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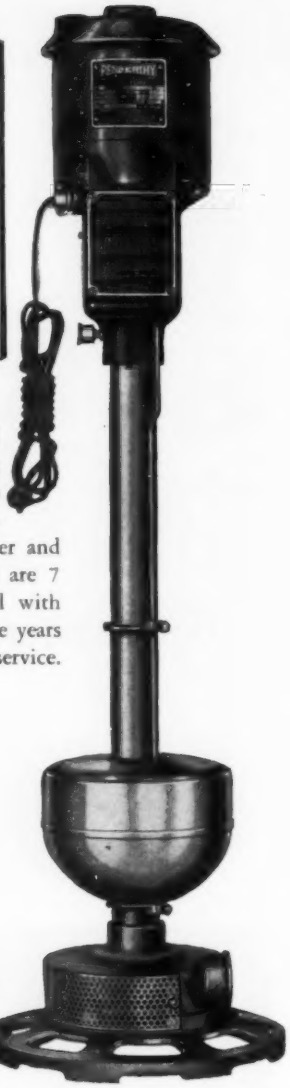

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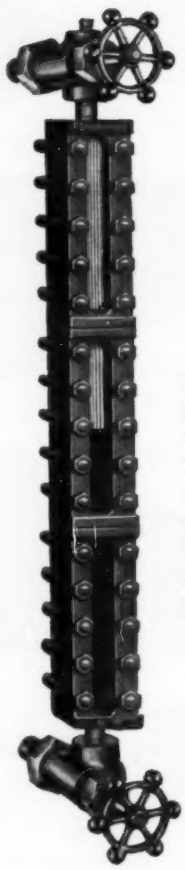

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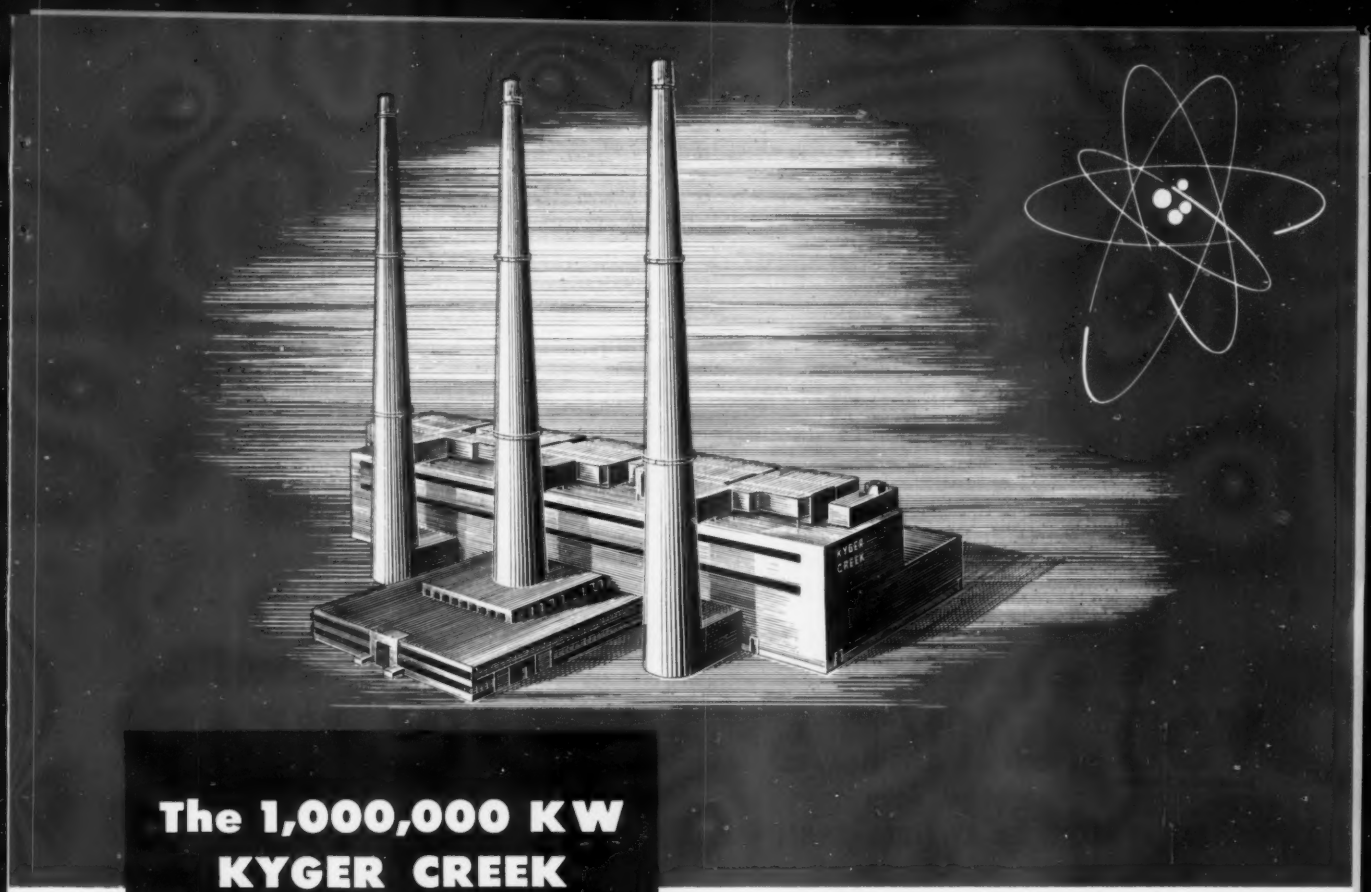

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Will Have MIDWEST PIPING Throughout

One-million-kilowatt Kyger Creek is the largest privately owned steam generating station for which one company has ever been designated to do both the fabricating and erecting of all piping. Operating conditions will be 2000 psi and 1050°F. Midwest was selected for this outstanding contract because of its long and successful experience in serving the public utilities and its exceptional fabricating and construction facilities.

The Ohio Valley Electric Corporation was formed by a group of 15 neighboring electric light and power companies. Kyger Creek is one of the two steam power plants being built to supply the power needs of the U.S. Atomic Energy Commission's new diffusion plant in Pike County, Ohio.

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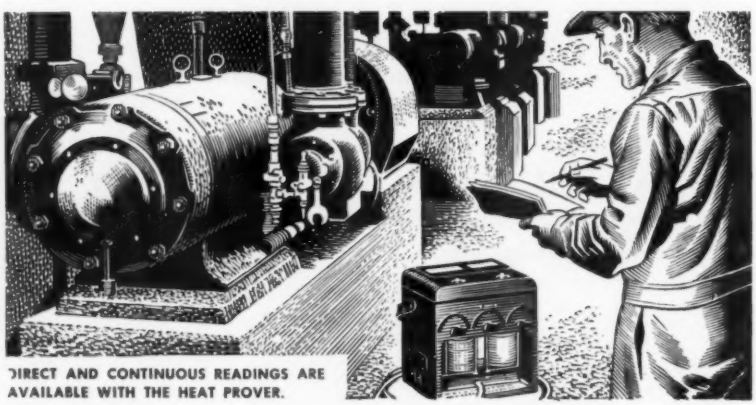
Many air-measuring methods allow only intermittent sampling of kiln gases. With the Heat Prover, direct and continuous readings of kiln combustion are available for immediate use . . . and the Heat Prover can bring about a considerable fuel savings and can substantially increase just about any cement plant's operating efficiency.

WHEREVER A FURNACE OPERATION IS INVOLVED the Heat Prover can help increase productivity and decrease operating costs. It samples rapidly and provides simultaneous and continuous readings of oxygen and combustible gases. The Heat Prover is portable—a technically accurate combustion analysis is obtained in a usable, practical manner. For details call your nearest Cities Service Office or write Cities Service Oil Co., Sixty Wall Tower, New York 5, N. Y.

BUT THE CITIES SERVICE HEAT PROVER CAN!

CITIES SERVICE

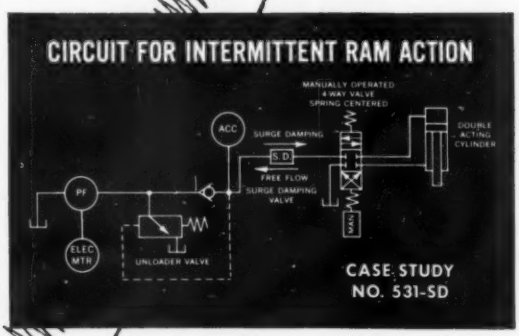
QUALITY PETROLEUM PRODUCTS



DIRECT AND CONTINUOUS READINGS ARE AVAILABLE WITH THE HEAT PROVER.

Protects hydraulic circuits

ACTUAL SIZE



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Denison Surge Damping Valve prevents hydraulic shock... eliminates damage to fittings, lines, seals and equipment

Sudden starting, sudden release of high pressure into a low pressure area, or reversal of flow causes a hydraulic surge as damaging to a circuit as blows from a hammer.

The Denison Surge Damping Valve converts the hydraulic surge into a smooth, gradually accelerated flow of fluid power. A hydraulically unbalanced reaction flow control in the valve causes the valve to open slower as the intensity of the surge increases.

Lightweight and easy to install, the Denison Surge Valve can be used on any circuit up to 5000 psi. Requires no adjustment . . . interferes in no way with the efficiency of the circuit.

The circuit shows a Denison Surge Damping Valve preventing hydraulic shock when stored-up energy in an accumulator is released. For a bulletin on the surge valve, write to: THE DENISON ENGINEERING COMPANY, 1214 Dublin Road, Columbus 16, Ohio.

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the modern way to transmit measurements

Advances in process engineering demand modern electronic transmission of measurement signals, particularly when continuous, accurate and instantaneous response is essential.

American-Microsen Electronic Transmitters are ideally suited to the requirements of the modern processing plant and power station. They measure variables at the source — a vital factor wherever inflammable, hazardous, poisonous or corrosive liquids and gases are handled. Such materials are controlled best when closely confined.

All American-Microsen Electronic Transmitters incorporate the Microsen Balance, a unique electronic "nerve center" with a rectified oscillator output of 0.5 to 5 milliamperes that serves as the accurate transmission signal. Even under severe temperature or supply voltage variations, accuracy within ½ of 1% of scale is obtainable.

The simple, two-wire DC system of American-Microsen Electronic Transmitters eliminates the installation and maintenance cost of pressure piping. And, linear output makes it unnecessary to match transmitters and indicators. The design of all American-Microsen Electronic Transmitters also permits service in relaying and for use with potentiometer receivers.

American-Microsen Electronic Transmitters are ruggedly built for reliable performance under the most severe operating conditions. Get complete information. Write for Catalog 400A.

General Purpose Case

Vapor Proof Case

Explosion Proof Case

AMERICAN
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A product of **MANNING, MAXWELL & MOORE, INC.** STRATFORD, CONN.

MAKERS OF 'AMERICAN' AND 'AMERICAN-MICROSEN' INDUSTRIAL INSTRUMENTS, 'HANCOCK' VALVES 'ASHCROFT' GAUGES, 'CONSOLIDATED' SAFETY AND RELIEF VALVES, AIRCRAFT PRODUCTS. BUILDERS OF "SHAW-BOX" AND 'LOAD LIFTER' CRANES, 'BUDGIT' AND 'LOAD LIFTER' HOISTS AND OTHER LIFTING SPECIALTIES.

Illustrated above are two of the four Triple Reduction Type Herringbone Speed Reducers, specified by the United States Army Corps of Engineers, Portland, Oregon, and furnished to the Monarch Forge and Machine Works, to operate with precise control, four 42′ x 39′ Radial Control Gates at Big Cliff Dam located on the North Santian River, Detroit, Oregon.

Its primary purpose will be to re-regulate the fluctuating discharges effected by the Detroit power plant. The water will be re-used to operate a power plant with an installed capacity of approximately 18,000 kilowatts.

Philadelphia Herringbone Gear Speed Reducers . . . meet all the requirements necessary for positive and economical transmission of power, with simplicity and high efficiency. The gears are arranged symmetrically with respect to the center line of the housing, producing equal loads on the bearings on each shaft, allowing a more compact design.

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Industrial Gears & Speed Reducers

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In Plants From Coast-to-Coast

SPECIFY ERNST WATER COLUMNS • LIQUID LEVEL GAGES • Bronze, Forged Steel, Stainless Steel, All Iron and other specialties • For all Pressures and Temperatures • For Boilers, Tanks, Heaters, Refinery Service, etc.

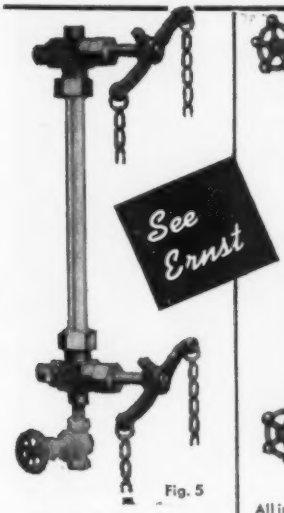


Fig. 5

Standard vertical bronze water gage, 350 pound design.

Fig. 8

All iron gages for pressure up to 250 lbs., heavier construction up to 350 lbs.

Fig. 8SS—Same fittings made in stainless steel.

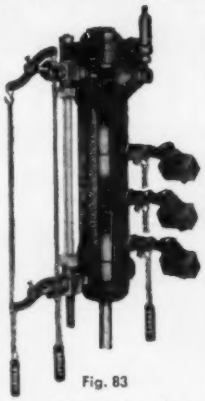


Fig. 83

No. 5 high and low alarm column wth vertical gages and DCP weighted type try cocks.

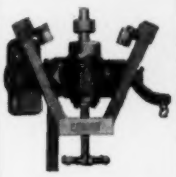
Wire or Phone Ernst

Fig. 1

DESIGNED FOR 250-450-650 LBS. W.S.P.

High and Low Alarm Column Equipped with Split-Gland Type Adjustable Inclined Water Gage

NO GAGE GLASS PACKING NUTS



Simple and easy to install a gage glass. No wrenches or tools required. A turn of the hand wheel compresses the packing.

Insure Safety with ERNST INSERTS

Mica-protected Flat Glass and PRISMATIC REFLEX

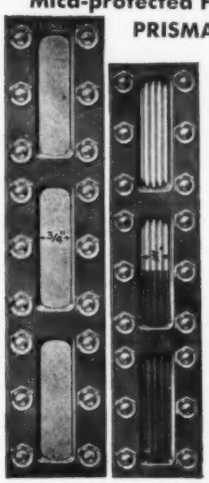


Fig. 44 EXT Fig. 34 EX

Insert units can be combined to make any desirable length for tanks, etc.

Fig. 45

Ernsthru Vision Mica-Protected Single Insert

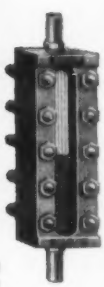


Fig. 37

Prismatic Reflex Steam Shows WHITE; Water shows BLACK

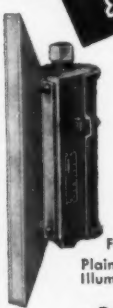


Fig. 10

Plain Sight Illuminator

Fig. 31

Ernst Plastic Guard, Replaceable Plates

ERNST LEAKLESS TRY COCKS

Made for all pressures up to 2500 lbs.

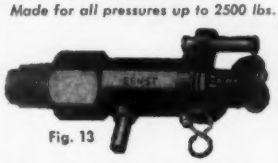


Fig. 13

Ernst Leakless Try Cocks Assure Maximum Safety

Fig. 01

Bronze, with Wheel

Weighted Type Try Cock

Fig. 15

Bronze, with Iron Weight Double Chain Pull

Spring Type Fig. AS-250

SIGHT FLOW INDICATORS for insertion into pipelines

"See what's going on" . . . inside

Fig. 17-28 Glass Cyl. Type

Fig. E-811 Flapper Type Single Window

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Fig. E-57 Double Window Type

GAGE GLASSES — Tubular and Flat Type

FLAT TYPE REFLEX AND CLEAR

CLEAR AND RED-LINE MAGNIFYING TYPE

Tubular Glasses Made in Lengths up to 144" Long

And Outside Diameters 3/8", 1/2", 5/8", 3/4", 7/8", 1", 1 1/4", 1 1/2".

STATE YOUR REQUIREMENTS

High Pressure Composition RUBBER GASKETS

Manufactured in all sizes to fit your water gages

Specify:

B—Inside Diameter

A—Outside Diameter

C—Thickness

Fig. 21—Lip Mold Rubber Gasket

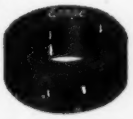

Fig. 22—Standard Rubber Gasket

ERNST WATER COLUMN & GAGE CO.

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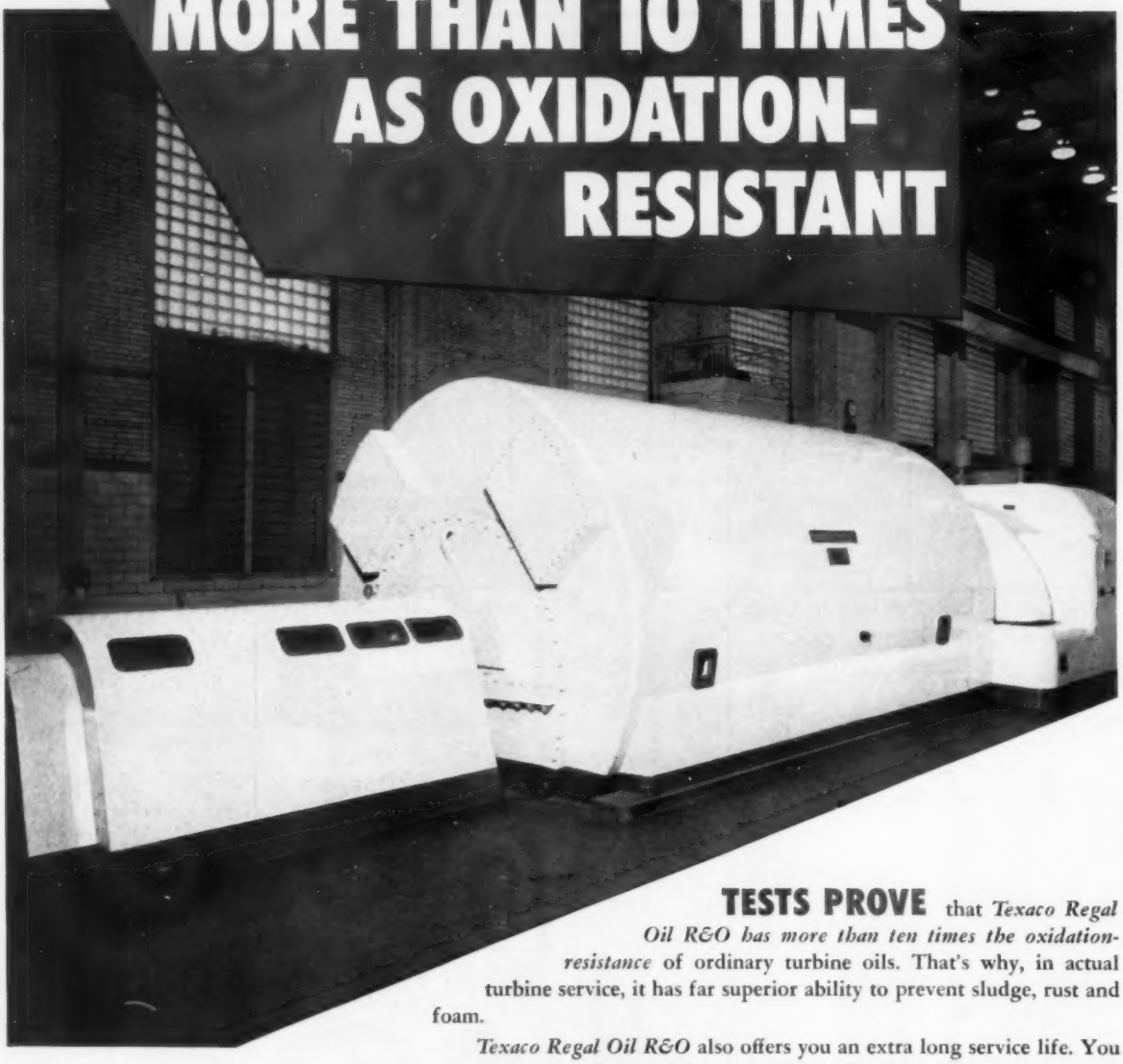
MORE THAN 10 TIMES AS OXIDATION-RESISTANT



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Texaco Regal Oil R&O also offers you an extra long service life. You can count on it to keep turbine systems clean, bearing temperatures normal, governor response instantaneous.

There is a complete line of *Texaco Regal Oils R&O* to assure these benefits whatever the size or type of the turbines. *Texaco Regal Oils R&O* meet the most stringent requirements of all leading turbine builders.

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TEXACO

TEXACO Regal Oils R&O

FOR ALL TURBINES

This Engineering Team

NOT LONG AGO I talked with Karl O Werwath, president of the Milwaukee School of Engineering. Karl is a leader in practical technical education. We agreed that the time has come for more attention to the "middle man" on the *engineering team*. Nobody forgets the Skilled Craftsman. Most everybody glorifies the Professional Engineer. Why do so many of us forget to acknowledge the other indispensable man of this team—the Engineering Technician?

Here is the substance of what President Werwath said to me about the forgotten man—the technician:

"The rapid advance of technology will force us to upgrade technical personnel at all levels. The trend is already evident in professional engineering circles, notably in the acceleration of the licensing program in our states.

"The time has come in our automation of industry to identify and recognize the engineering technician. We must let everybody know clearly the technician's place and his responsibility in our American economy.

"A start has been made by three nationwide organizations. First, the Engineers' Council for Professional Development has, for some ten years, been engaged in accrediting the "technical institute" type of curriculum. Second, the Technical Institute Division of the American Society for Engineering Education has contributed a growing bibliography of professional papers in this important area.

"Third, for over a decade, National Council of Technical Schools has engaged in the approval of such courses, as offered in private schools. During 1954, the NCTS has prepared a series of occupational monographs on the ten major fields in which engineering technicians are now employed—a helpful tool for all who advise and plan a program of technical education.

"I firmly believe that certain schools of higher learning, particularly those under private sponsorship, have an increasing responsibility to establish technical institute type courses. The moving force behind such curricula may well be *private industry*, so that these educational programs will best meet the needs of our free-enterprise economy.

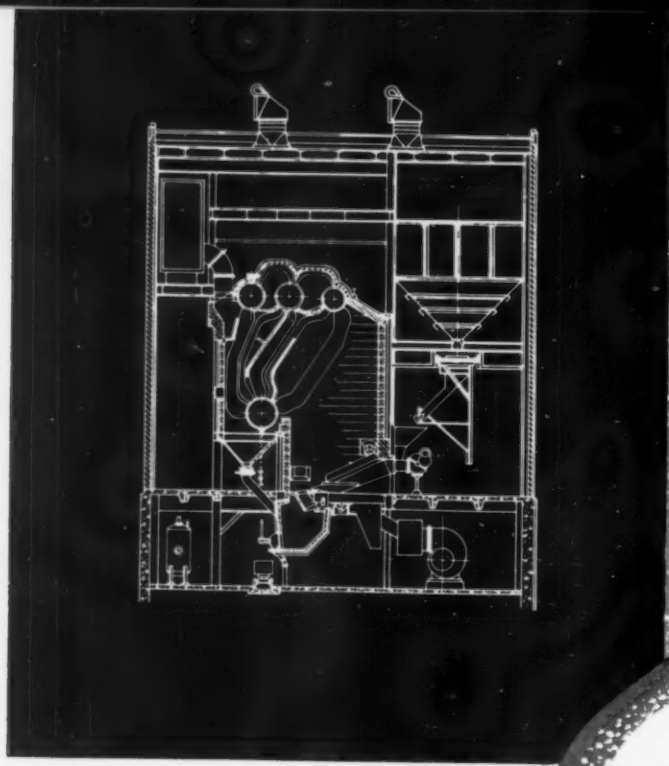
"We hear much about the demand for engineers. One obvious remedy is to increase the number of well-trained engineering technicians. Many times we find engineers doing jobs that could be performed as well, at least in part, by technicians. The best figures now available call for at least five engineering technicians to each professional engineer on the engineering team. Our current situation is almost the reverse—four engineering graduates to each technician.

"This doesn't mean that we need fewer engineers. Rather, it means the engineers will need more co-workers.

"Certainly the situation calls for closer cooperation between *industrialists and educators* to develop courses that will most efficiently serve the interests of all concerned—serve the young man desiring a career in some phase of engineering achievement—serve industry requiring responsible technical and business-minded personnel, and serve a free-enterprise society. America needs men who, in addition to their own productive efforts, will contribute to civic affairs through their own free decisions."

I fully agree with Karl Werwath. A team is a team, and we can't safely overlook any essential member. The technician is just as significant as the professional engineer and the skilled craftsman.

Let us all work to build greater opportunities and wider recognition for these new essential co-workers in the American engineering team!



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ON STOKERS

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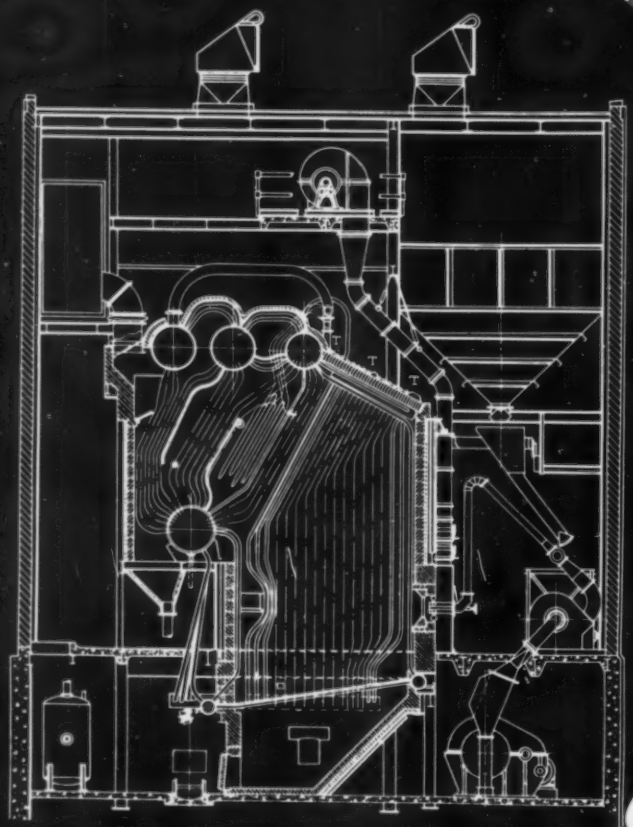

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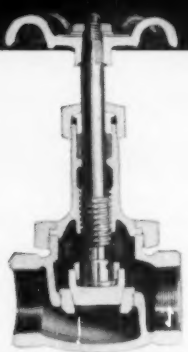

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Power
JULY 1954

Two new slants on deionization: keeping up water quality and... lowering operating costs

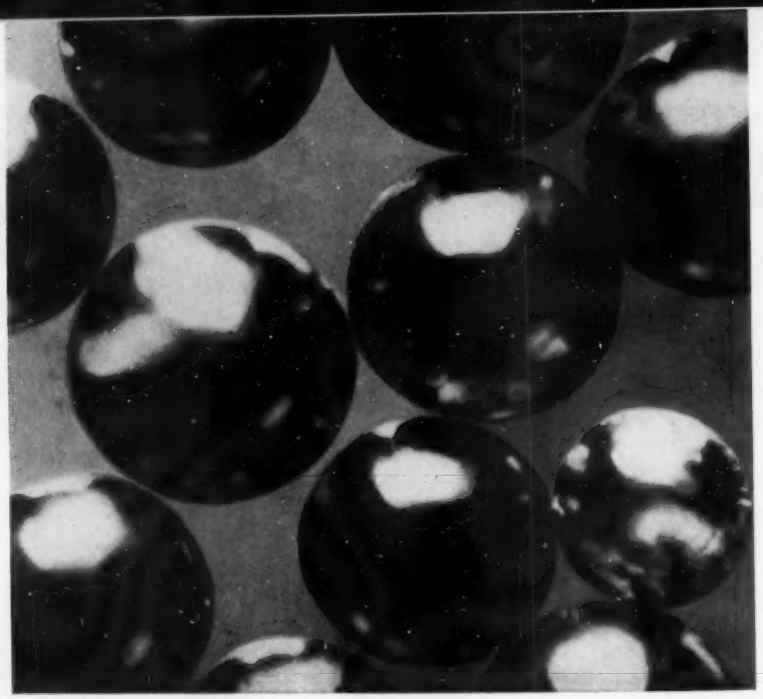
Recent research tells us that appreciable quantities of organic material can give unexpectedly low effluent quality. Workers in the field trace the effect to large organic ions. Our first article discusses this problem and suggests three possible solutions.

Deionizer efficiency, p 76

In general, a soft-water influent affords the best guarantee for continuous high capacity, and a high-quality effluent. But there are times when a hard-water supply cannot be avoided. Our second article analyzes the effect of hard-water on deionizer capacity, effluent quality and the cost of deionization equipment

Deionizer costs, p 79

By F X McGARVEY
Rohm and Haas Company
and A C REENTS
Illinois Water Treatment Company



PHOTOMICROGRAPH of uncontaminated ion-exchange resins. Limited capacity to adsorb large organic ions now seems reason for water-quality drop of some exchangers

Puzzled by drop in quality of water from your ion exchanger? Check for large organic ions

► USERS of ion-exchange deionization systems which process surface waters or water containing organic wastes have in the past reported an unexplained drop in effluent water quality, much below the high quality normally expected from such systems. Mixed-bed systems, which could produce water having a resistivity in the range of 5 to 10 $\times$ 10^6 ohms-cm, have been found to deliver water having a resistivity of only 5 to 7 $\times$ 10^5 ohms-cm.

Similar though less marked reductions have been noted in the performance of 2- and 3-bed deionization systems employing weak-base anion exchangers. But, because these systems normally produce water in the 1 to 5 $\times$ 10^5 ohms-cm range, the reduction in effluent quality is smaller and less readily observed.

One of the first units to exhibit this phenomenon was a 2-bed system employing a weak-base anion exchanger and a sulfonic-type cation exchanger. The unit was used to deionize a raw water during part of its cycle and, following this, to deionize recirculated rinse water.

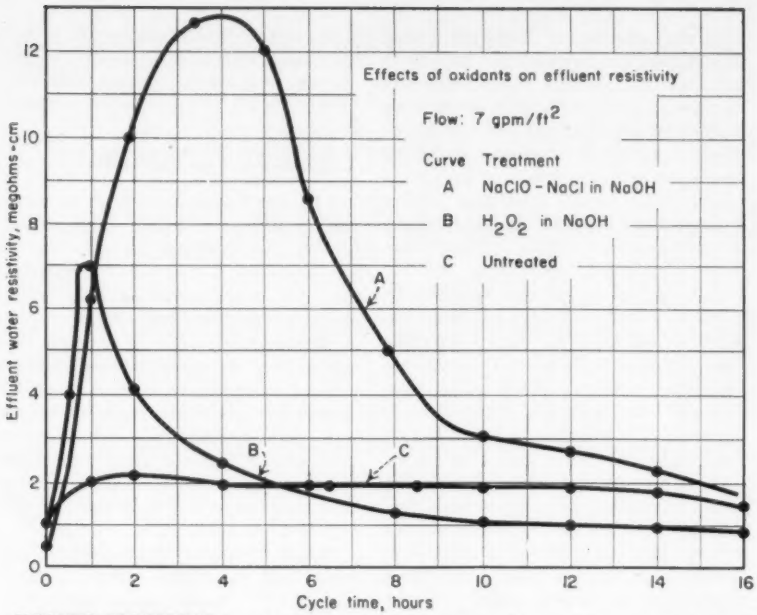
When raw water was being processed, the operation was normal—pH 5.5 and residual salts about 5 ppm as NaCl. When deionization of the recirculated rinse water was begun, the effluent-water pH dropped to about 3.9, and the higher conductivity reading indicated an increase in ion concentration to about 20 ppm. When raw water was again passed through the exchange unit, the pH rose to the normal value, and the conductivity dropped.

The exchange resins were tested and found normal. Difficulty was traced to the presence of an organic acid, probably a lignin derivative, in the recirculated rinse water. The weak-base anion-exchange resin would not exchange this acid, even though it was dissociated to a considerable degree. The molecular weight of the acid was very high, hindering diffusion through the resin particle. When this acid was eliminated from the recirculated water, the operation became normal again.

This problem is not confined to any one type of deionization system. In addition to the weak-base anion resin discussed above, the difficulty has occurred with strongly basic quarternary-type anion exchangers used in either multiple-bed or mixed-bed installations.

SOURCE OF TROUBLE

Recent research, conducted jointly by Rohm & Haas Co and Illinois Water Treatment Co, shows that the unexpectedly low effluent quality is due to the inability of the anion resin to adsorb appreciable quantities of organic materials present in the water supply as large ions. Because of the low ad-



CLEANUP PROCEDURE is one means of solving the problem of large organic ions. Several agents have been used in this method—the results from two are shown above

sorption, the large organic ions leak rapidly through the resin bed, largely accounting for the lowered effluent resistivity.

Previous research by other workers supports this conclusion. Kunin and Myers (4)* have reported on the effect of ion size on anion exchange. Gregory (1) and Kressman (3) have shown that ion separations can be made on the basis of ionic size. Hale and others (2) have studied the effect of large ion pickup on polystyrene-based cation exchangers. They reported that quarternary ammonium ions diffuse into the resin at rates that are inversely related to their molecular weight. The pH of the solution was also found to have an influence on the completeness of exchange. They found, further, that highly cross-linked resins lose cross-linkage and swell irreversibly when fully exhausted with large ions. The exchange of other ions was found retarded by the exchange of large ions.

Influence of surface-water supplies on the problem is variable. From some sources it is virtually impossible to produce any high-quality water—that is, water having a resistivity greater than 1×10^6 ohms-cm. From other sources good-quality water can be obtained for several cycles, following which the effluent quality gradually drops off until virtually no capacity above 1×10^6 ohms-cm can be observed.

One other effect that generally occurs from organic fouling of the resin is that the pH of the effluent is about one unit lower than usually obtained with well water. This pH effect, like resistivity drop, is less apparent in the multiple-bed than in the mixed-bed units.

Although no theory has yet been developed to answer all aspects of the problem, a simple qualitative explanation can be given based on well-known ion-exchange principles.

Size of the ion that can be exchanged is limited by the pore size of the resin. In this case, pore size is the space available in a 3-dimensional network for an exchanging ion. Surface area plays only a minor role in the exchange of large ions although sometimes the only capacity available may be on surface groups. Commercially available exchangers are relatively highly cross-linked and have limited capacity for ions greater than 250 in molecular weight.

When large ions do exchange on the surface of these materials, they tend to diffuse slowly into the resin structure to the greatest degree possible. Materials that diffuse slowly into a resin structure will diffuse out equally slowly. Therefore, it is exceedingly unlikely that regeneration, which takes a relatively short time, can free the resin from these fouling ions that have been diffusing inwardly for a much longer time. In addition, polyfunctional ions have considerable affinity for the exchangers so it is not easy to remove them by the usual regeneration.

Physical adsorption may play a role with some of these compounds. It is also possible that polymerization condensation reactions, which are catalyzed by the exchanger groups, may take place and lead to the formation of large resinous bodies trapped inside or on the ion-exchanger surface.

Procedures have been devised for avoiding or correcting the problem of fouling. One or more of these steps may be called for: (1) Use ion-exchange resins of greater porosity that not only removes large organic ions from the water, but also releases these contaminants when regenerated with mineral acid and sodium hydroxide. (2) Utilize a cleanup procedure on the resins, done either cyclically or periodically. (3) Remove or destroy the organic materials in the water by suitable pretreatment.

HIGHLY POROUS RESINS

It is possible to modify the porosity of ion-exchange resins by varying the degree of cross-linkage. Several slightly cross-linked resins, such as Amberlite IRA-401 and IRA-411, have been developed with a porosity great enough to permit the adsorption of ions having molecular weights in the range of 1000. Large ions diffuse more rapidly into these resins than into their highly cross-linked homologues. It can be predicted that these exchangers should reduce large-ion leakage and should be more easily regenerated. True, large ions can diffuse farther into the resin structure so that the exchangers may become seriously fouled after long use. Since they are regenerated more easily, however, a net compensating effect may result.

It has been argued that as large ions force their way into resin structures, high pressures will be created that may rupture chemical bonds in the resinous structure. The pressure required to rupture a chemical bond is quite large but may be approached by osmotic pressures in the exchange zone. Hale and others (2) reported a reduction of 4% in apparent cross-linkage when studying the exchange of tetraethyl ammonium ions on a sulfonated polymer of styrene divinylbenzene (15% DVB).

*For research references, see page 78.

Substitution of more highly porous resin was tried on one system that originally consisted of a cation-exchange unit containing Amberlite IR-120, followed by an aerator, and a mixed-bed unit containing Amberlite IRA-400 and IR-120. The influent water was drawn from a surface supply. With the original resins, the effluent resistivity never exceeded 1.5×10^6 ohms-cm and the pH ranged from 5.5 to 5.8.

The anion resin was removed, and Amberlite IRA-401, the porous version of this resin, was substituted. Effluent resistivities averaging 10×10^6 resulted, and the pH was 6.8, or what would be expected with no organic acids present. Operation has been entirely satisfactory since the change.

RESIN CLEANUP

For many years, workers in the field of ion exchange have attempted to rejuvenate anion-exchange materials. Until 1949, these anion-exchange materials were the weak-base type, relatively unstable to chemical treatment. The methods employed to rejuvenate these early materials could be applied easily and with more assurance to the strong-base exchangers developed in 1949, since these later exchangers are stable chemically to oxidizing and reducing agents in dilute solution.

Some of the following treatments have been applied: (1) Rinse with sulfuric and hydrochloric acids, at concentrations varying from 2 to 30%. (2) Rinse with alkalies such as sodium hydroxide, sodium carbonate and ammonium hydroxide at concentrations of 2 to 20%. (3) Treat with reducing agents like sodium sulfite, sodium hydrosulfite and nascent hydrogen. (4) Wash with salt solution of 5 to 15% concentration using sodium chloride or sodium sulfate. (5) Treat with mild oxidizing agents like hydrogen peroxide and sodium hypochlorite.

The amount of organic material adsorbed or exchanged by ion-exchange resins is undoubtedly quite small in comparison with the total anion capacity. Many of these organic materials, however, are held quite tenaciously and are not completely removed by the usual hydroxide or acid regeneration.

Once the resin structure has been fouled with large ions, their condensation products, or both, rather drastic treatments may be required to free the exchanger of these materials. Since the hydrocarbon structure of the exchanger is quite inert chemically, it should be possible to remove the more highly reactive organic groups by chemical treatment. Consider both oxidants and reductants. Both may be required.

Dilute solutions of hydrogen peroxide and sodium hypochlorite have been used for this problem. The reduction of complex aldehydes to their alcohols by sodium hydrosulfite has been proposed. These reagents will free the exchanger structure of organic matter by breakdown of the contaminant into smaller groups that can diffuse easily from the resin particle. Such treatments have been used in field operations.

Solution of a fouling problem by resin cleanup is pictured in the graph. The resins involved were Amberlite IRA-410 and IR-120. Conventional cleanup procedures using acids, alkalies and salts were ineffective. Next, a mixture of 3% hydrogen peroxide and 3% sodium hydroxide was tried. After 12-hour contact with this solution, the resins were placed in a pilot mixed-bed unit, backwashed and regenerated. The column was then operated on raw water containing dissolved organic materials. Average resistivity was raised to about 6×10^6 ohms-cm for a period of one hour, and thereafter decreased. This indicated that sufficient organic material was removed to reactivate some exchange groups so removal of organic acids was again possible. For the treatment to be practical, however, the resins should have produced water of high resistivity for a much longer time. Two additional cycles were made using this treatment, but no better results were obtained in this particular instance.

The next solution used was 10% sodium chloride and 3% sodium hypochlorite. The same resins and the same procedure as above were used. With three hours of operation, the resistivity rose to 14×10^6 ohms-cm. A total of three cycles was made, using this treatment.

Specific resistance readings from 8 to 14×10^6 ohms-cm were recorded. This was a definite improvement over previous methods of cleanup and was chosen as the most promising cleanup procedure for this particular water.

References:

(1) H Gregory, T Bregman, F Gutoff, R Bradley, D Baldwin, and C Overberger—*Journal of Colloid Science* 6, 20 (1951)

(2) D Hale, D Packham, and K Pepper—*Journal of Chemical Society*, 1953, 844

(3) T Kressman—*Journal of Physical Chemistry* 56, 118 (1952)

(4) R Kunin and R J Myers—Discussion Faraday Society #7, 114 (1949)

(5) E Nordell — *Water Treatment*—Reinhold Publishing Corp 1951

(6) M Taras—*Journal of American Water Works Association* 45, 47 (1953)

CHEMICAL PRETREATMENT

The third possible solution to large-ion fouling is chemical pretreatment. It would be most helpful to be able to identify exactly the organic materials that cause contamination. But unfortunately these materials are very complex and usually occur in mixtures that are difficult to separate. Contaminants can be expected to occur in surface waters from decaying vegetable matter and would contain hydrolysis products from the cellulose structure of wood, pigments and fibrous fragments from bark and leaves, and proteinaceous materials from animal life.

Initial treatment would remove colloidal and suspended substances, and only truly soluble materials would reach the resin bed. Many of these are nitrogenous compounds, which, as reported by Taras (6), are highly complex and amphoteric. So one would expect to encounter compounds with amino-acid properties as well as polysaccharides and partly oxidized sugars.

In the field it is particularly difficult to make a quantitative analysis of organic materials present. Color index and chemical oxygen demand, about the only convenient field tests, are shown by Nordell (5) to be unrelated to each other. Sometimes the amount of oxygen consumed may be greater for slightly colored waters than for highly colored ones. Nor can color be used as an index of the total amount of organic matter present, although color does definitely indicate the presence of some organic material.

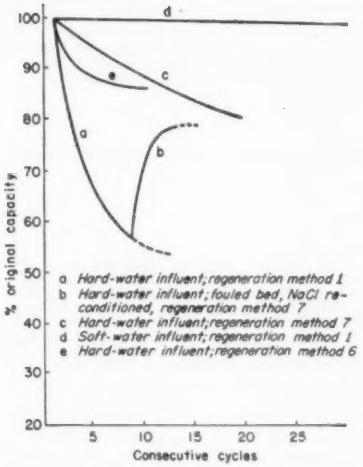
Color bodies in water are known to be one of the factors that influence the operation of strong-base anion-exchange resins. This color is relatively easily removed by coagulation, sedimentation and filtration. The treatment is well known, having been reported many times in the literature. But despite coagulations and filtration, "before and after" oxygen-consumed tests showed that some organic ions still remained in the water.

Chlorination is one of the methods for eliminating organic bodies by oxidation. The process of so-called "superchlorination"—with one to four hours retention—is probably the most satisfactory. Other oxidants, such as hydrogen peroxide, potassium permanganate, and ozone, can be used, but their cost and handling problems must be considered carefully.

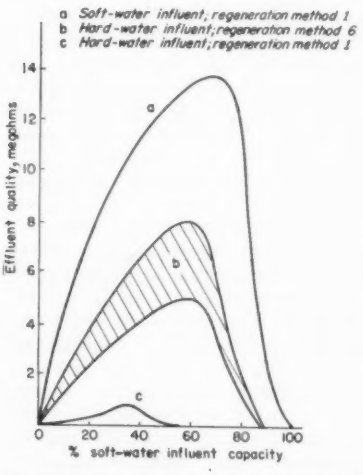
Second deionization article on facing page.

Economic and operating aspects of mixed-bed deionizers with hard- and soft-water supplies

By J F McGILL, *Chemical Research Director, Elgin-Refinite, Division of Elgin Softener Corporation*


% original capacity
Consecutive cycles
a Hard-water influent; regeneration method 1
b Hard-water influent; fouled bed, NaCl reconditioned, regeneration method 7
c Hard-water influent; regeneration method 7
d Soft-water influent; regeneration method 1
e Hard-water influent; regeneration method 6

1 Mixed-bed deionizer output: hard and soft influents; various regenerants


a Soft-water influent; regeneration method 1
b Hard-water influent; regeneration method 6
c Hard-water influent; regeneration method 1
Effluent quality, megohms
% soft-water influent capacity

2 Typical long-range results: mixed-bed deionizers with various regenerants

► WHERE HIGH-QUALITY EFFLUENT is required from mixed-bed deionizers, repeated, unfailing operation must be assured. Hardness in the influent, which can interfere with production of high-quality effluent, appears to have received too little consideration in the past.

In this problem, high quality, though important, is not the sole factor. Even with effluent of satisfactory quality, a fall in capacity means that equipment operation is inefficient and uneconomical. So we find the economic aspect entering the picture.

Influents of two types can be chosen for mixed-bed deionizers: soft water containing only the salts of sodium and hard water containing the salts of calcium, magnesium and sodium. A question immediately arises: Just what are the effects of each type of supply on mixed-bed deionizer operation? Studies undertaken by a number of equipment manufacturers show that they are aware of the advantages and disadvantages of the two types of influent and are anxious to develop operating procedures that will give best results for a specific influent.

Extensive lab and field results with sodium-ion influent repeatedly show the ability of the equipment to consistently produce high-quality effluent at high-capacity cycles. Lab tests have produced effluent with less than 0.02-ppm ionic solids*, a quality of about 12.0 megohms specific resistance, over a course, of nearly 100 cycles with no abnormal drop in unit capacity, curve *d*, Fig. 1.

Service-cycle lengths were based on turn-in and turn-out points of 50,000 ohms specific resistance. These limited, direct observations are supported by continuing excellent results produced by several dozen mixed-bed deionizers in the field for periods of one to three years. In some cases the units have had close to 500 regenerations.

Hard water. Attempts to use hard water as an influent to a mixed-bed deionizer have revealed some extreme though not surprising results. Both effluent quality and unit capacity were immediately and quite adversely affected by the switch from sodium-ion supply. Now lab tests have been made to reveal more precisely the ramifications of operating with hard-water influent.

Of necessity, lab study was limited to a narrow range of operation. But conditions representative of a large percentage of water supplies were chosen. Synthetically prepared soft-water influent contained 22 gpg of sodium salts as chloride, alkalinity, sulfate and silicate. The synthetically prepared hard water contained 45% calcium, 23% magnesium and 32% sodium in a total of 22 gpg of cations. This gave an influent with about two-thirds hardness with a 2:1 calcium-to-magnesium ratio.

Regeneration. To establish a base for operation with a soft-water influent, and a comparison with hard-water influent, regeneration by method 1, Table I, was used. In all instances, the anion exchanger (Rezex-42, a type II, strongly basic anion exchanger) and the cation exchanger (Rezex-5H, a high-capacity, polystyrene, nuclear sulfonic cation exchanger) were each rinsed with soft water until a residual of 100 gpg of alkalinity or acidity was obtained.

Comparing results using soft- and hard-water influents with standard regeneration, method 1 gives facts largely academic and serves merely as a contrast because of the extremely poor results obtained with hard-water influent

* Unless otherwise stated, all concentrations are expressed in terms of calcium carbonate equivalents.

Attempts to use hard-water influents for mixed-bed deionizers reveal some very interesting results

Table I: Summary of regeneration techniques

Method	Hard-water influent to mixed-bed deionizers: Anion exchanger (Rezex-42) regenerant*				Cation exchanger (Rezex-5H) regenerant**				
	Regen level #/ft³	Regen concen %	Regen and rinse flow rates g/ft²/m	Mode of regen‡	Regen level #/ft³	Regen concen %	Fraction of regen at given concen	Regen and rinse flow rates g/ft²/m	Mode of regen‡‡
1	5.0	5.0	1.0	A	7.0	5.0	1	1.5	C
2	5.0	5.0	1.0	B	7.0	1.5	½	1.0	C
						5.0	½	1.0	
3	5.0	5.0	1.0	B	7.0	0.5	½	3.3	C
						1.5	½	1.3	C
						5.0	½	0.5	
4	5.0	5.0	1.0	B	6.0	6.7	1	1.5	C
					7.0	1.5	½	1.5	C
						5.0	½	1.5	
5	5.0	5.0	1.0	B	6.0	6.7	1	1.5	C
					7.0	2.5	1	1.5	C
6	5.0	5.0	1.0	B	10.0	6.7	1	1.5	C
					7.0	1.5	½	3.0	C
						5.0	½	1.0	
7	5.0	5.0	1.0	B	10.0				
					7.0	6.7	1	1.5	D
						5.0	1	1.5	D
8	5.0	5.0	1.0	B	15.0				
					7.0	6.7	1	1.5	C
						1.5	½	1.5	C
						5.0	½	1.5	
9	5.0	5.0	1.0	B	15.0				
					7.0	6.7	1	1.5	C
						2.5	1	1.5	C
10	5.0	5.0	1.0	B	15.0	10.0	1	1.5	C

*Regenerant — common caustic
**Regenerant — Methods 1 — 3: 66 deg Be H_2SO_4
Methods 4 — 9: NaCl, 66 deg Be H_2SO_4
Method 10: 30% HCl (muriatic)

‡A: Downflow through entire bed
B: Downflow through Rezex-42 only
‡‡C: Downflow through Rezex-5H only
D: Upflow through Rezex-5H only

with no modification of the standard regeneration technique.

Curve *a*, Fig. 1, shows the rapid capacity decline met in the first ten hard-water influent cycles. By the end of the one-hundredth cycle, capacities of less than 50% of original might be expected. Also, quality decline or increased leakage is to be expected.

Quality decrease is due to cation leakage caused by the fouled cation exchanger resulting from precipitation of calcium sulfate within the bed when a standard sulfuric-acid regeneration is used with hard-water influent. Higher pH of effluent is conducive to greater silica leakage, a most undesirable condition where silica removal is one of the major functions of the mixed-bed deionizer. Table II shows how hard- and soft-water influents stack up economically when standard regeneration is used.

Investment. Increase capital investment by a factor of 1.33 for hard-water influent and standard regeneration when unit is to produce an identical amount of deionized water as with a soft-water influent. This reflects the increased equipment size needed to provide a capacity double that with soft water.

Regenerant cost, including a small softener for deionizer regeneration, is 1.68 times that for the same equipment for soft-water influent. In all instances, either soft or deionized water must be supplied for deionizer regeneration. Otherwise, magnesium hydroxide and calcium sulfate forming in the caustic or acid regenerants would foul the exchangers, giving far poorer results than indicated here.

Labor cost is the only slight advantage in favor of hard-water operation. This was because the small softener was sized to be regenerated once every three deionizer regenerations, while the softener supplying soft-water influent was most economically sized at one regeneration for every two regenerations of the deionizer unit. A higher labor cost for deionizer regeneration with hard-water influent reflects an increased anion-exchanger rinse time. Labor costs were based on an earlier study, but the hourly rate was increased to $2.50, instead of the $1.75 first used.

Practical aspects. Disadvantages of a hard-water influent with standard regeneration prevent recommending its use except under the most extenuating circumstances. However, we are faced with the problem of finding the best methods for such a situation when it does arise. Study of a mixed-bed deionizer with pre-regeneration of the cation exchanger with a 6.7% sodium chloride solution at a level of 10 lb NaCl per cu ft of Rezex-5H cation exchanger gave an immediate capacity increase, see curve *b*, Fig. 1 on p 79.

Because of the improvement of unit capacity on a previously fouled bed with introduction of a pre-regeneration of the Rezex-5H with sodium chloride, this technique was tried on a freshly prepared bed, method 7, Table I. With this method the various regenerants contacted only their respective exchangers. Curve *c*, Fig. 1, shows test results.

Unit capacity still decreased markedly, but nowhere near the extreme experienced when no sodium chloride was used. But capacity drop was enough to cause an appreciable rise in regenerant cost per 1000 gal of effluent. To produce an equal volume of deionized water from the same-capacity equipment, six regenerations were required as compared with five for soft water.

Other methods. Many techniques have been suggested to allow use of hard-water influent with mixed-bed demineralization equipment. Some of the best methods studied by the author or his coworkers are listed in Table I. Of the outlined procedures, method 6 appeared most satisfactory. Normal effluent qualities of five to eight megohms with capacities as high as 89% of those with soft water were obtainable. However, an occasional cycle had extremely low quality, not exceeding 0.5 megohm, and poorer capacity. These occurred when there were slight variations in the

Table II: Mixed-bed deionizer operation after 100 cycles

All data based on standard equipment most economically sized to produce 10,000 gal of deionized effluent per cycle, 1,000,000 gal per yr with 100 cycles on 22 gpg as $CaCO_3$ soft- or hard-water influent

	Soft-water influent	Hard-water influent		
	Standard regeneration Method 1	Standard regeneration Method 1	Best regeneration Method 6	HCl regeneration Method 10
Equipment				
Deionizer	$5380.00	$8758.00‡	$5836.00‡	$6330.00
Softener	1760.00	790.00	685.00	685.00
	$7140.00	$9548.00	$6521.00	$7015.00
Yearly cost of operation				
1. Equipment amortization on 10-year basis	$ 714.00	$ 954.80	$ 652.10	$ 701.50
2. Regenerant cost*				
Deionizer	NaCl- NaOH $360.00 H_2SO_4 180.00 — 540.00	NaCl- NaOH $790.00 H_2SO_4 354.00 — 1144.00	NaCl- $310.00 NaOH 470.00 H_2SO_4 217.00 — 997.00	NaCl- NaOH $ 360.00 30% HCl] 1103.00 — 1463.00
Softener	NaCl 180.00	69.00	37.50	37.50
3. Labor**				
Deionizer	469.00	500.00	500.00	469.00
Softener	156.00	105.00	78.25	78.25
4. Interest: 5% per annum, on capital investment	357.00	475.00	306.00	351.00
5. Total	$2416.00	$3247.80	$2570.85	$3100.25
Deionized effluent cost per 1000 gal	$ 2.42	$ 3.25	$ 2.57	$ 3.10

*Regenerant cost basis:
NaOH.....$0.04 per lb
H_2SO_4..... 0.02 per lb
30% HCl (muriatic)..... 0.06 per lb
NaCl..... 0.02 per lb

**Labor: $2.50 per hour
‡Standard units with additional ion-exchange materials added to provide adequate capacity

regeneration. One or two additional cycles were often needed to return to average results with hard water. Careful use gave results in curve *e*, Fig. 1.

Table II shows method 6 has lowest equipment costs. Deionizer requires a few more cubic feet of resins, while the softener supplying soft water only for regeneration is much smaller than that for a deionization cycle. Softener supplies enough water for regeneration of the demineralizer four times, the most economical balance for this particular operation.

High cost of deionizer regenerants, 1.44 times soft-water costs, makes this process uneconomical. Labor is slightly more because additional time is needed for pre-regeneration of the cation exchanger. At best, this method is about 1.06 times more costly than with soft-water influent.

Alternate technique, method 10, Table I, uses the equivalent of 15 lb of 30% HCl per cu ft as cation exchanger regenerant in place of H_2SO_4. No insoluble compounds form during cation regeneration. As Table II shows, high acid cost usually makes this procedure too uneconomical when compared with others.

Other disadvantages include the corrosive nature of HCl and the need for a small softener as in method 6. In general, HCl regeneration of the cation exchanger is not recommended procedure.

In place of a small softener, enough deionized effluent may be stored to regenerate the deionizer. Normally, however, such a procedure is not used; deionized effluent is more expensive than soft-water and a large enough storage tank of the proper material usually costs more than a softener.

Economic advantages of soft-water supply with best regeneration, method 6, may decrease slightly when a deionizer as small as 10- to 14-in. diameter is used. But abandoning soft-water feed in place of a modified regeneration with hard water is risky because lab tests show that only slight changes in recommended hard-water regeneration procedures, which could occur accidentally, cause fouling, lower the capacity, and affect effluent quality. Much treatment would be needed to restore the bed to a satisfactory condition.

Slight variations in regeneration with soft-water influent do not measurably affect capacity or quality. Generalizations indicating possibilities of operation without presoftening are hazardous; only analysis of economics and water quality will insure the correct answer.

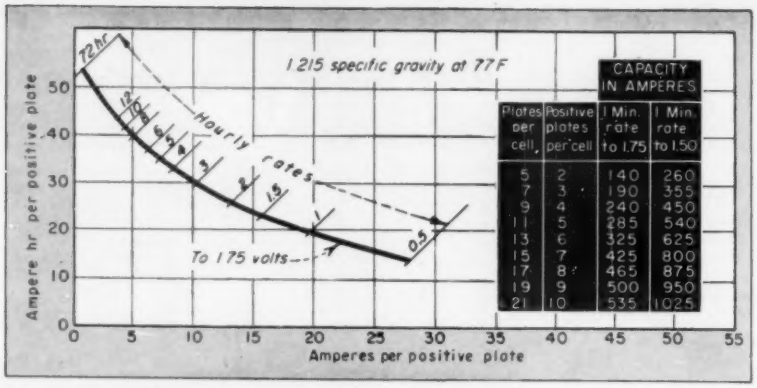
One other factor worth noting is the effect of temperature on cation-exchanger regeneration. Calcium sulfate, the material causing interferences in regeneration, is more insoluble at higher temperatures. So precautions should be taken to keep the temperature as close to 50 F as possible during regeneration of a unit having hard-water influent. This applies to any method of regeneration using H_2SO_4 with hard-water supply. It is complicated when a "hot" caustic regeneration of the anion exchanger is used where extremely low silica is a factor in effluent quality.

Questions are often asked regarding the limits of hardness in an influent to a mixed-bed deionizer. The critical factor appears to be the ratio of calcium to total cations rather than the absolute amount of this ion. Lab and field operation of mixed-bed deionizers indicates that calcium ions can be present to an extent of about 10% of the total cations before any serious capacity or quality drop occurs.

Though not following directly from any individual set of lab results, data in Fig 2 are based on an accumulation of observations from different sources and can be considered typical operating results that are normally expected under some of the conditions studied.

In general, the use of soft-water influent affords the best guarantee for continuous maintenance of both high capacity and high quality over a large number of cycles. And it has been found to be economically ahead of any other operating methods studied.

How to select the right size control battery



Plates per cell	Positive plates per cell	CAPACITY IN AMPERES: 1 Min. rate to 1.75	1 Min. rate to 1.50
5	2	140	260
7	3	190	355
9	4	240	450
11	5	285	540
13	6	325	625
15	7	425	800
17	8	465	875
19	9	500	950
21	10	535	1025

1 After analyzing the load requirements, pick off cell capacity in amperes from table, *right;* apply to curve after dividing it by the number of positive plates

Ample battery power for switchgear operation, pilot lights and emergency lighting is a key factor in plant reliability. Here are all steps needed to size batteries, outlined by K A Vaughan, Manager, Field Engineering, Gould-National Batteries Inc

► GENERATING STATIONS and substations need dependable power supplies to operate controls, safety devices and indicators, often under widely varying conditions. The usual power source is control batteries. They must be large enough to meet emergency requirements, yet not so large that they increase battery costs unnecessarily. You can check battery size needed in your plant, as outlined below. Your figures should jibe with the calculations supplied by the battery manufacturer.

Study the load. Start by splitting the load into three groups: switchgear, pilot lights, emergency lighting or power loads. Load duration is generally different in each of these cases. The closing of switchgear requires less than a second, pilot lights may call for continuous current while emergency lighting or other power equipment must be supplied over some definite span in an emergency.

Determine the plates-per-cell for each type load since batteries have different capacities at different discharge rates. You find total battery size by adding the plates-per-cell required for all three types of service.

Selecting number of cells in battery is simple since power-station control apparatus is standardized at 120 or 240 v. Actually, most equipment today operates at 120 v with an allowable variation between 90 and 140 v. Select a 60-cell battery for 120-v equipment. Since battery voltage depends on number of cells (each cell contributes 1.75 v when discharged) the minimum voltage of a 60-cell battery is $60 \times 1.75 = 105$ v. This is 15 v above minimum permitted for equipment. The excess of 15 v offsets the IR drop caused by circuit resistance between battery and control equipment.

Select a 120-cell battery for 240-v equipment. Such equipment will operate satisfactorily when voltage varies from 180 to 280. The 120-cell battery that is not seriously undercharged always provides a voltage within this range.

Switchgear. Use the one-minute battery rate to compute number of plates per cell needed for repeated closing of switchgear. Capacity must be large enough for the combined load where more than one switch is closed at the same time. As a practical measure, where fewer than 20 circuit breakers are installed, it is generally assumed that but one closing operation will occur at a time. However, as many as half the breakers may trip simultaneously. Less current is needed for tripping than closing. Therefore, a battery with enough capacity for closing will be large enough for tripping as well. But to be safe, calculate both current requirements, using the larger when determining battery size. Since switchgear closings seldom repeat at less than 2-second intervals, a battery with enough capacity for simultaneous closings will also have enough capacity for repeated closings.

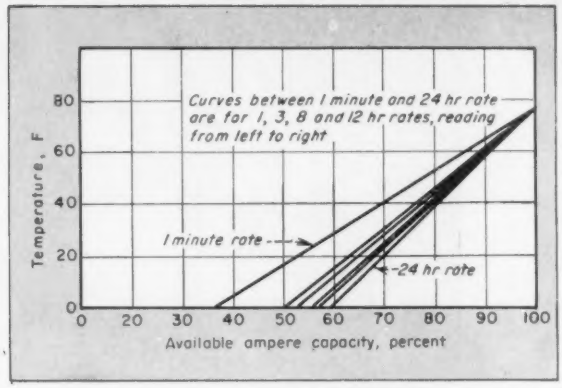
Lighting load. Pilot light load is the total number of lights multiplied by the current drain of each. Time during which pilot light load must be carried depends on the individual installation, whether attended or unattended.

Where control batteries handle emergency lighting, determine the ampere load for estimated duration of any emergency, varying from a very few minutes to perhaps 12 hr.

Determining cell size. Having found ampere values for the three load types and time periods for which these loads must be carried, the appropriate number of plates-per-cell can be found from curves and other data supplied by the battery manufacturer. These data for each battery include (1) the capacity per positive plate at one minute rate for different cell sizes (2) a curve giving capacity in both amperes and ampere-hours per positive plate for longer discharge rate (3) a temperature-correction curve.

Temperature-correction curve is necessary since battery capacity varies somewhat with battery temperature. Standard capacity curves are for behavior at a standard temperature of 77 F. Above that, capacity increases slightly; below it, capacity decreases slightly. Amount of this capacity correction depends on discharge rate—low temperatures affecting the one-minute rate more than the 8-hr rate.

To make temperature correction, establish the temperature under which battery will operate. Base correction on


Curves between 1 minute and 24 hr rate are for 1, 3, 8 and 12 hr rates, reading from left to right
1 minute rate
24 hr rate
Temperature, F
0
20
40
60
80
0 20 30 40 50 60 70 80 90 100
Available ampere capacity, percent

2 Temperature-correction curve is needed since capacity will vary with temperature. Above curve is for standard, 77 F

lowest ambient temperature of the year. In heated attended stations, the correction is usually too small to bother with. On the other hand, temperature corrections for unattended stations may become significant if operation is to be safe in winter months.

To find correct number of positive plates per cell, use manufacturer's data for battery type under consideration. Determine for each load condition the available ampere capacity per positive plate. Correct each of these values for lowest ambient temperature of service. Divide these ampere capacities, in turn, into the ampere requirements for their corresponding types of load. Thus you arrive at a calculated number of positive plates necessary to handle each type of load that will be met.

Add these figures for each load to get total positive plates per cell. If this total contains a fraction that is greater than 5% of the integer, increase the integer by one. Otherwise, neglect the fraction. Double this whole number and add one to get the proper number of plates, both positive and negative, per cell.

Here's how the method works. Suppose a 60-cell control battery is required to meet the following loads at a temperature not lower than 55 F:

1. Switchgear requirement: one switch requiring 90 amp to close.
2. Pilot light requirement: one amp for eight hours.
3. Emergency light requirement: seven amp for three hours.

Necessary data for particular battery being considered are shown in Fig. 1. These data vary with battery types. Temperature-correction curve for all lead-acid stationary batteries is illustrated in Fig. 2.

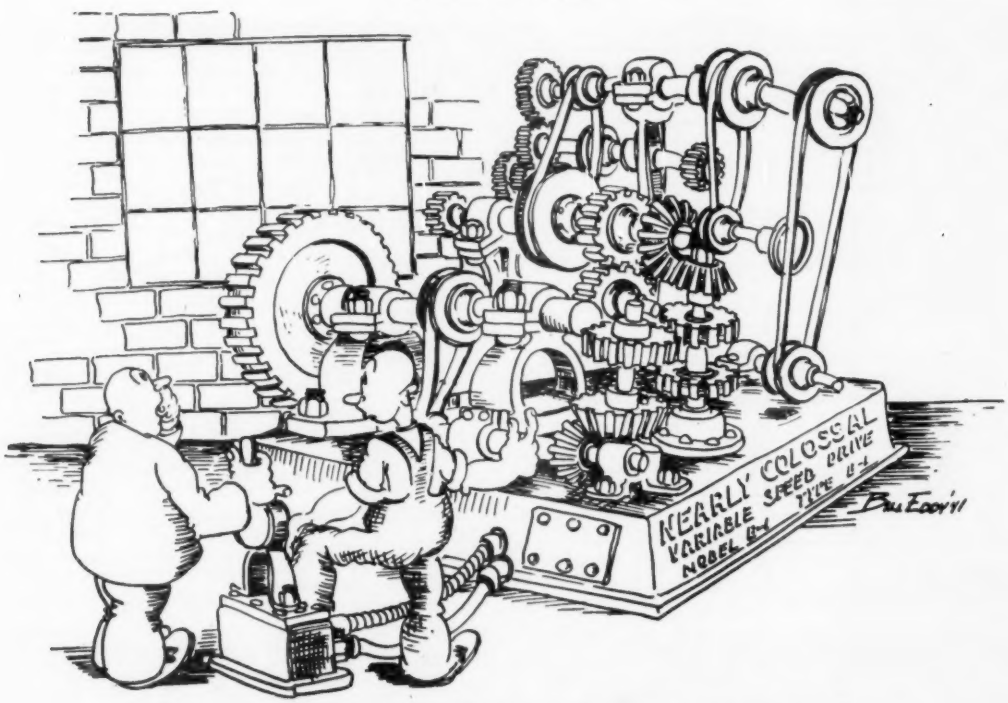
Starting with an approximate battery size of 9 plates-per-cell (4 positive plates), first tackle the switchgear load.

From the tabular data in Fig. 1 for one-minute discharge to 1.75 v, the ca-

(*Continued on page* 218)

No. 7 of the Bill Eddy cartoons

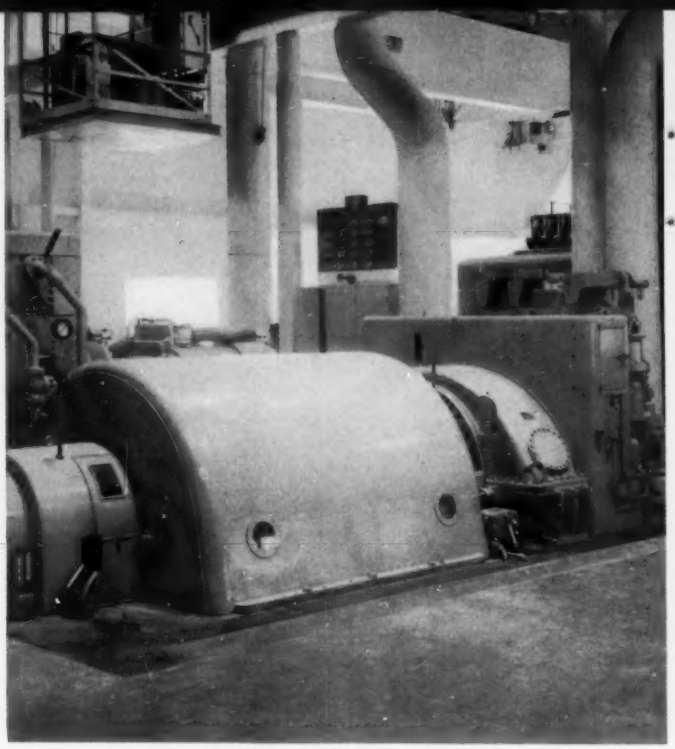
Repeated by request



"This is our superspeed reducer—No matter what you do, output is zero"

FIRST OF A SERIES*

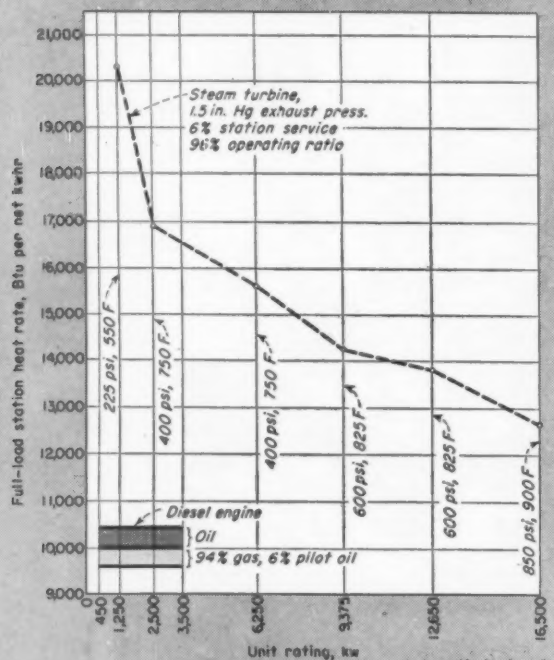
By C M STANLEY and S K FOSHOLT
Partners
Stanley Engineering Company
Muscatine, Iowa



There is no magic formula. Only careful consideration of the individual factors involved will lead you to an intelligent decision on whether to use . . .

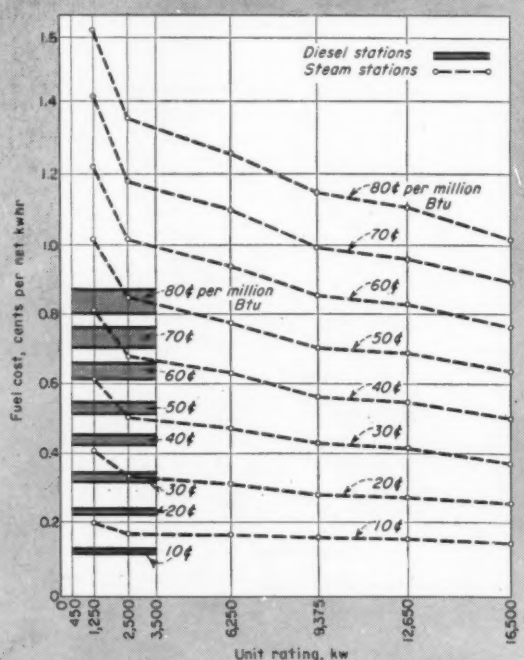
. . . Steam and

*Based on 1954 American Power Conference paper



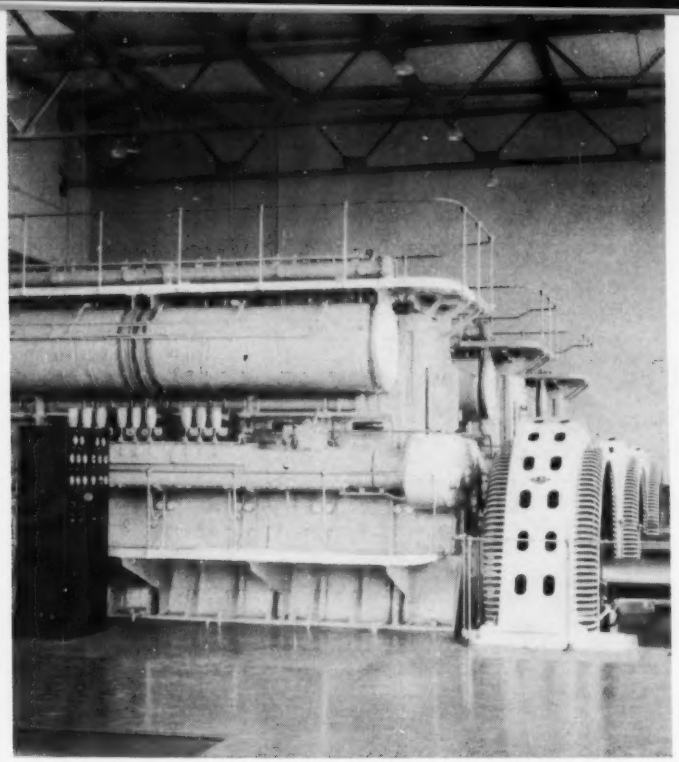
Note 1 Steam-station heat rates are for unit ratings plotted only
Note 2 Assumed boiler efficiencies vary from 83% for 1250 kw unit to 86.5% for 16,500 kw unit

1 Comparative steam- and diesel-station full-load heat rates used to determine fuel costs shown in Fig. 2



Note 1 Steam-fuel costs are for unit ratings plotted only
Note 2 For dual-fuel equipment, fuel price noted is average price of all Btu consumed

2 Probable fuel costs of steam and diesel stations in cents per net kwhr based on delivered prices shown



CONSIDER THESE POINTS

- **Fuel cost per net kwhr**
- **Initial investment per kw of installed capacity**
- **Reserve-capacity requirements**
- **Fixed charges**
- **Payroll cost**
- **Maintenance and other costs**

or Diesel... for your small or medium-sized power plant

► TODAY'S INCREASING DEMAND for economical electrical power compels power engineers to face up to many complex problems associated with facilities expansion. Engineers in small and medium-sized power plants tackle one of the toughest of these problems when they are called on to select the right prime mover for electrical generation. There are seldom two cases exactly alike. So it's necessary to grasp the underlying principles rather than apply a hard and fast formula that's likely to give misleading answers.

In the pages that follow we're going to discuss a general approach to the problem of choosing between a steam, a diesel or a combination plant. To pinpoint the conditions further, we'll consider plants generating electrical energy, without steam requirements for process or heating. Steam turbines studied will not exceed 16,500 kw. Maximum diesel-engine capacity considered is 3500 kw.

Economic factors that affect the cost of power are: (1) *fuel cost per net kwhr* (2) *investment per kw of capacity* (3) *reserve-capacity requirements* (4) *fixed charges* (5) *payroll cost* (6) *maintenance and other costs.* In addition, several other items not affecting cost are frequently weighed. Now let's examine these, one at a time, and see how they lead the way to a sound selection of steam, diesel or a combination for your power plant.

Fuel cost per net kwhr. This factor is so important that consideration of it alone often decides your choice. No other single cost varies over such wide ranges. It depends not only on size and characteristics of the equipment, but also on the delivered price of the fuel, which varies tremendously. For a true yardstick, multiply station heat rate in Btu per net kwhr, as a measure of equipment performance, by delivered fuel price in cents per million Btu. The result is fuel cost on a cents-per-kwhr basis.

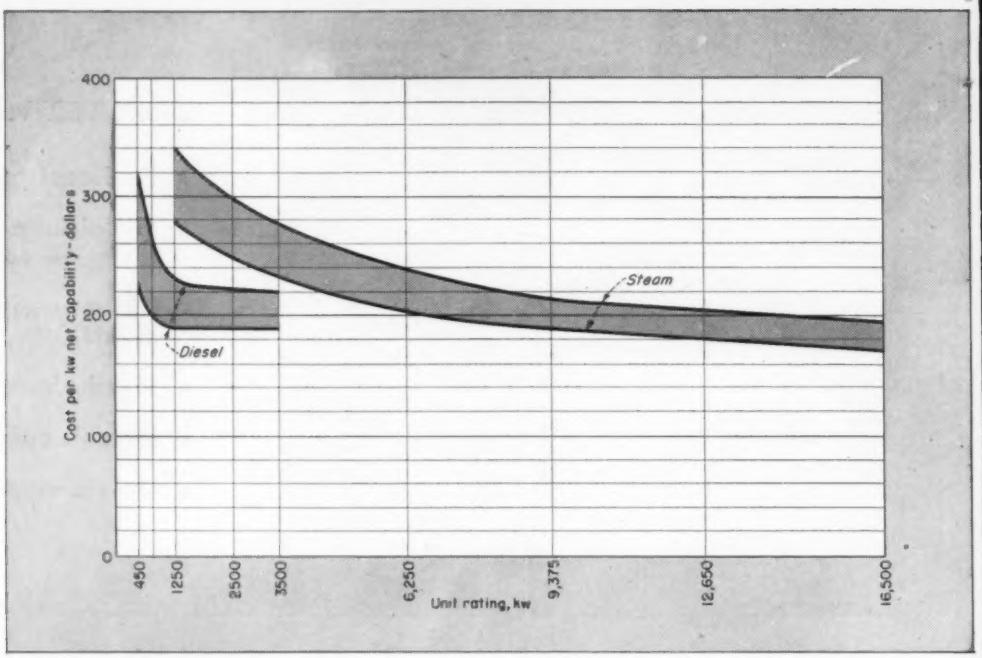
Fuel prices have varied over the years and from one geographical area to another. Experience shows that the following spread defines realistic limits:

Coal	15¢ to 40¢ per million Btu
Gas	10¢ to 45¢ per million Btu
Diesel oil	45¢ to $1.00 per million Btu

Fuel requirements for diesel engines vary only slightly with unit size. We've plotted diesel guarantees and test results in Fig. 1. Notice that full-load heat rate for sizes from 450 to 3500 kw is practically constant. Heat rates include 4% station service.

Let's turn our attention now to characteristics of steam-turbine plants. Full-load steam-station heat rates are also plotted in Fig. 1. These are for the stated steam conditions and are in line with current practice. Unlike the diesel, steam units show wide variations in heat rate with changes in unit size and steam conditions. In presenting this graph we've included varying amounts of regenerative feedwater heating. Spread is from one feedwater heater for the 1250-kw unit to four heaters for the 16,500-kw unit. Also reflected is variation in boiler efficiency from 83 to 86.5% over the same range of capacities.

It's a simple matter to apply delivered fuel prices to these heat rates to get the fuel cost in cents per kwhr shown in



3 Probable construction costs of steam and diesel electric-generating stations. Lower limit indicates single-unit addition, while upper limit indicates new plant

Economic factors play key role—but they must be tempered by local conditions

Fig. 2. For dual-fuel diesel units, fuel prices tabulated are the composite price of gas and pilot oil. Diesel costs also include a charge of 0.03¢ per net kwhr for lubricating oil. This simplifies presentation of comparative costs.

Study of Fig. 2 shows up several important facts: (1) *Diesel-equipment fuel costs are not affected by unit size.* (2) *Steam-plant fuel costs drop rapidly for the larger units.* For example, a 37% decrease in full-load head rate is shown within the range of sizes studied. (3) *Diesel plants show a lower fuel cost per net kwhr than even the largest steam unit when delivered fuel prices are same.* (4) *It is the delivered fuel price that is of prime importance in figuring relative fuel cost for your economic studies.*

Don't overlook a comparison of part-load heat rates either. Under some conditions these play a key role. Typical figures in percent of full-load heat rate are:

Percent of	*Diesel*		*Steam*
rated load	*Oil*	*Dual fuel*	
100	100	100	100
75	98-102	98-108	99-102
50	100-110	110-130	102-106

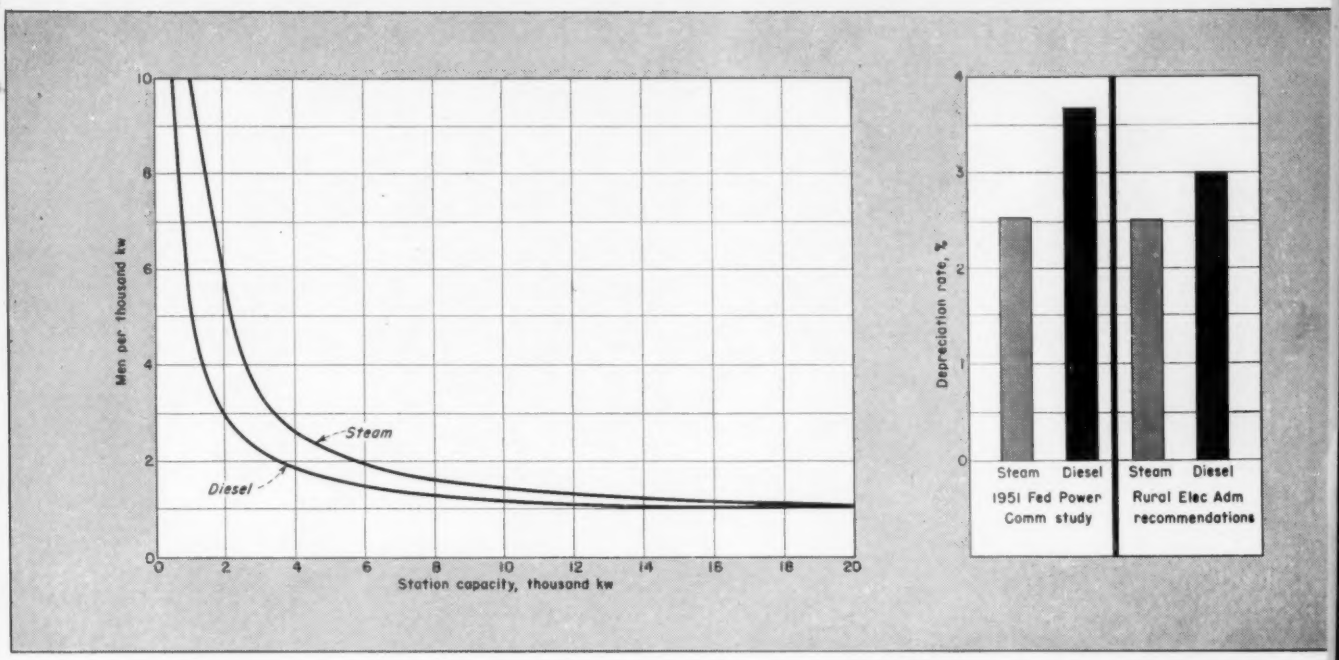
Investment per kw of capacity. Plant-construction costs depend on many factors. Foundation conditions, cooling-water supply, size and number of units, type of building, outgoing electrical circuits and even geographical area, to mention a few. Only the study of a specific case results in a realistic investment figure. But because comparisons are vital to a complete picture of the comparative economics of steam and diesel plants, we'll at least indicate the probable cost ranges under assumed conditions.

Probable construction costs

Diesel generating stations		*Steam generating stations*	
Unit rating, kw	*$$ per kw net capability*	*Unit rating, kw*	*$$ per kw net capability*
450	230-320	1250	280-340
750	200-265	2500	250-300
1250	190-230	6250	205-240
2500	190-225	9375	190-215
3500	190-220	12,650	180-205
		16,500	170-195

This table is based on the same conditions shown in Fig. 1 and 2. The data reflect certain specific projects that have been used as a guide and adjusted to show up changes in construction-cost levels, foundation conditions, and comparable design and facilities. Lower limit of the range indicates cost of a single-unit addition to an existing plant where basic station facilities are available. Upper limit shows cost of a new plant with two or three units. We've also assumed normal foundation conditions. Don't forget that these are only average costs and may change considerably with local conditions. The table is shown graphically in Fig. 3.

Reserve capacity requirements. An accurate appraisal of this important item depends on the type of load you serve. Generally speaking, they fit into one of the following categories: (1) *Isolated plant, shutdown permitted.* If your units may be taken off the line at night, over weekends, or during vacation periods, and if forced shutdowns can be tolerated, then a reserve unit is not necessary. The full capability of the plant may be used to carry load. (2) *Isolated plant, shutdown not permitted.* If your load is such that equipment cannot be taken out of service for scheduled maintenance,



4 Average station personnel requirements (including normal maintenance crew). Actual requirements can vary from 10 to 20% depending on local conditions

5 Government surveys: basis for recommended utility depreciation rates

and engineering know-how that can't always be figured in dollars and cents

then dependable capacity must be at least equal to maximum demand. Such conditions call for a reserve unit equal in capacity to the largest unit in the plant. (3) *Interconnected plants.* If your plant is tied to other sources of power capable of supplying reserve, then installed reserve should be from 10 to 20% of maximum demand.

Categories (1) and (3) require installed capacity comparable to the load. Therefore, they show little, if any, preference for steam or diesel.

On the other hand, if you're studying an isolated plant where shutdown is not permitted, an appreciable difference in the amount of reserve capacity is required, depending on whether you select steam or diesel units. And there's a good reason for it. Steam plants use fewer and larger units to attain the lower heat rates and construction costs. Diesel plants by their very nature show little improvement in heat rate or construction cost when sizes above 1000 kw are considered. They, therefore, use more and smaller units.

For example, if a 10,000-kw load is to be supplied, chances are three 5000-kw steam units (one in reserve) giving 33 1/3% standby capacity might be selected in a steam generating plant. Compare this with five 2500-kw diesel units (one in reserve) selected to handle the same load, giving 20% reserve capacity. If you're planning an isolated plant that can't tolerate shutdowns, the reserve capacity factor should bias your decision in favor of diesel. Remember, however, that other considerations can outweigh this one.

Fixed charges include depreciation, insurance, taxes and interest or return on investment. For purposes of our study we can express fixed charges as a percentage of investment.

Of all the items that comprise fixed charges only depreciation has any appreciable variation with type of equipment you'll pick. Depreciation rates vary from 2½ to 5% depending on the policies of management. But evidence provided by operating records shows a definite justification for lower depreciation rates when steam equipment is used. Results of two government studies of this subject are shown graphically in Fig. 5. As a guide for estimates, you can figure on using depreciation rates for diesel plants that are ½ to 1% higher than those for steam plants.

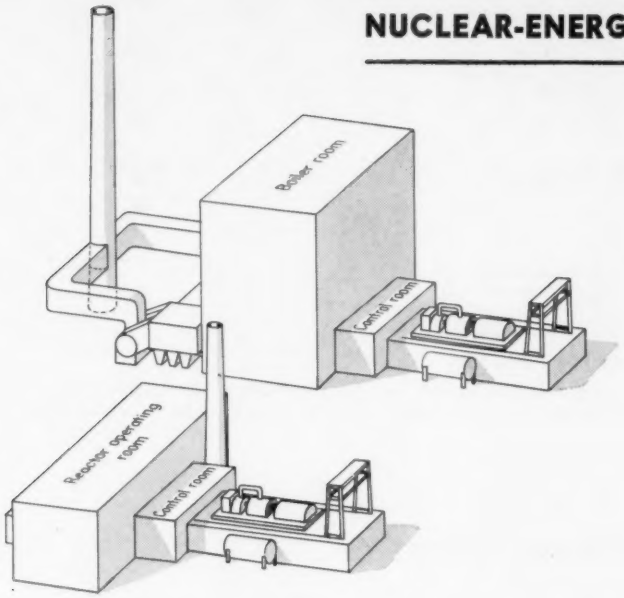
Insurance costs, not including payroll taxes, average about 0.25% of the investment. Taxes vary from zero for a nontaxable municipal plant, to 2% or more of the investment, depending on prevailing tax rates and assessment policy. Interest runs anywhere from 2 to 6%, based on the source and cost of the borrowed funds. If you figure fixed charges to yield a return on investment rather than interest, chances are you'll peg this return at 6% or better, depending on management policies and regulatory commission practices.

We've now taken a look at all the usual elements that enter into fixed charges. Of these, only depreciation rate tends to favor steam equipment. With the exception of this difference, the effect of fixed charges on the relative economics of steam and diesel depends only on the relative investment required.

Payroll costs. While no appraisal of steam and diesel is complete without consideration of this factor, remember that we can speak of average conditions only. Your setup may differ by as much as 10 to 20% because of differences in design, number of units and management-union agreements. Study of payroll-cost elements is therefore, a must item.

(*Continued on page* 216)

Swarms of speeding electrons surround widely spaced nuclei of uranium atoms



Here's your key to nuclear energy

In a matter of years, uranium will be put in harness alongside coal, gas, oil and falling water to carry the world's power load. Now's the time to learn how uranium can be used to generate electrical power

By **HENRY C SCHWENK**, *Henry Pratt Company*

and **ROBERT H SHANNON**, *United Engineers and Constructors Inc*

► ONE OF THE MOST SIGNIFICANT developments of our time has been release of the energy within the atom. Circumstances dictated that this energy be used initially for destructive purposes. We are now, however, on the threshold of harnessing atomic energy for peacetime uses, 15 years after the atom was first fissioned. Private industry is at last beginning to exert its talents toward developing the peacetime future of the atom.

The power industry is stimulated in its effort to develop economial nuclear power by the knowledge that a 100,000-kw power plant can run on the equivalent of less than a pound of fuel a day. This power can be made available without severe geographical limitations or the need to be close to fuel source. Station size may be materially reduced and underground location may be feasible.

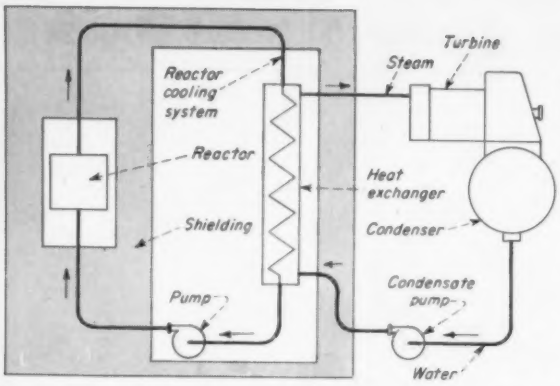
The power industry is anxious to see that electricity generated by nuclear energy takes its place as a supplement to the methods it now uses. This is essential because:

1. With the exception of hydroelectric power, our present energy sources are finite in amount. With our expanding economy, population and power demand we can foresee serious depletion of our fossil fuels.

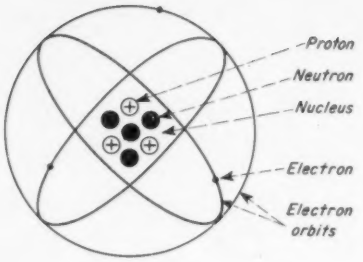
2. The rising cost of conventional fuels offsets the diminishing increment savings achievable through improved fuel-utilization techniques.

3. The firm conviction prevails that (a) technological development in the atomic field will move forward at a faster rate under the competitive spur of private industry (b) economy-minded private utilities can do most to achieve generating costs competitive with conventional means.

4. Our nation's best interests are served by maintaining leadership in the field of atomic-energy developments. We will be in a position to materially assist our



1 Simple nuclear-power plant has reactor delivering heat to exchanger to generate steam for conventional turbine unit



2 Schematic of atom (lithium) shows nucleons in center with electrons traveling about them in certain paths or orbits

Lethal radiations make use of special precautions necessary

free-world allies whose costs of conventional power generation are prohibitively high.

5. A nuclear-power plant may simultaneously produce large amounts of power and fissionable material. This (a) makes these plants an important national asset (b) extends our energy resources (c) contributes to a state of military preparedness (d) reduces investment in fissionable-material production plants.

Power engineers' future. Now is the time for the power engineer to prepare himself for the future. This study course will start that preparation. It aims to give the engineer (1) a good review of basic nuclear physics (2) an understanding of what takes place inside a reactor (3) fundamentals of nuclear-power plant design. In short, an understanding of nuclear power, its potential, its technology, its inherent limitations.

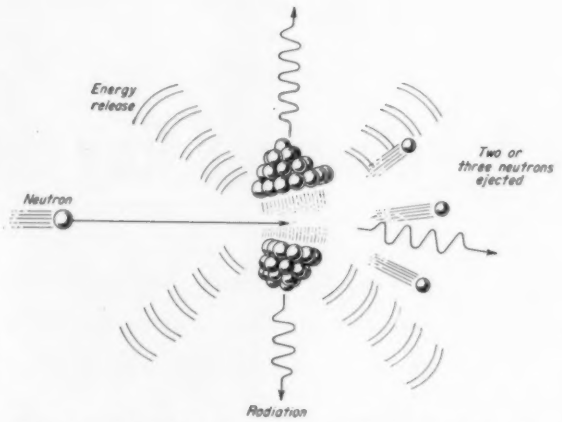
The secrecy aspects of atomic energy have put it behind its own iron curtain. The aura of mystery has made it assume an unnecessarily imposing stature. The elementary concepts of nuclear physics and reactor engineering are not difficult—only new. Once the language and idea barriers are broken down the engineer should easily assimilate a working knowledge of the fundamentals.

This series of articles will be written for the power engineer—in his language—without any sacrifice of considerations needed to thoroughly understand the subject.

Nuclear-power plant. Before studying any nuclear fundamentals let us look at the basic considerations of nuclear-power generation. This should develop a "feel" for the subject and help you orient the material that follows.

In a nuclear-power plant the nuclear reactor produces heat energy by the fissioning (splitting) of the nuclei of certain atoms. This heat directly, or indirectly, generates steam for a conventional steam turbine. Thus nuclear and conventional power plants differ only in the heat source.

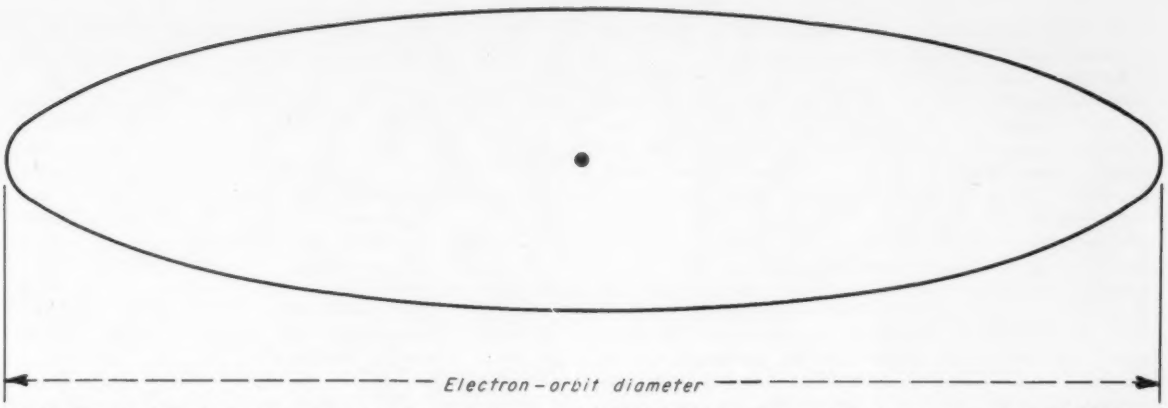
The nuclear reactor, heat-transfer system and simplified steam-generating equipment replace the conventional steam-boiler and the fuel- and ash-handling facilities. Sketch in p 89 shows how a conventional steam plant and nuclear plant of the same capacity might compare in size. Heat-producing and steam-generating facilities in the latter occupy much less space than in the conventional steam plant.



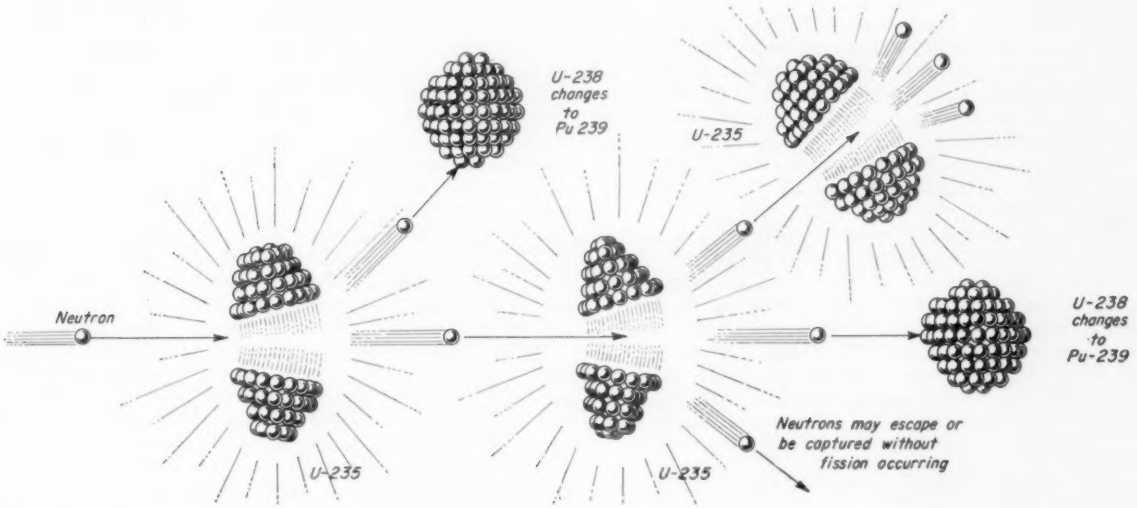
4 U-235 nucleus hit by neutron splits (fissions) into two smaller atoms, emits 2 or 3 neutrons, radiations, energy

Fig. 1 shows a simplified schematic of a nuclear-power plant. Fissioning of uranium atoms in the reactor produces heat picked up by the cooling medium. The latter delivers this heat to the heat exchanger to generate steam for the turbine. The reactor and its cooling circuit must be heavily shielded to confine hazardous radiation within the reactor and coolant circuit.

Energy source. An atom is a basic particle of matter. Each element has its own characteristic atoms. These atoms, probably, have an internal structure that resembles a tiny solar system with more than 99.9% of its mass concentrated in the central sun or nucleus. The nucleus consists of infinitesimally small particles called nucleos. There are two types: protons and neutrons. Neutrons have no electrical charge. Protons, on the other hand, have a positive charge, each balanced by a negatively charged electron orbiting as a "planet" about the nucleus. Thus the whole atom is electrically neutral. Fig. 2 shows a schematic diagram of a lithium atom. This gives no idea of the relative sizes and distances involved within the atom.



3 An atom (hydrogen) consists mostly of empty space from a volume standpoint. Electron orbit diameter is only about 1/100,000,000 in. But nucleus diameter is only 1/10,000th of orbit diameter; as drawn above it is 100 times too large



5 In chain reaction, neutrons emitted by fissioning U-235 can fission other U-235 atoms. When U-238 atom captures neutron it changes to plutonium after several days. Fission raises temperature of mass. Neutrons may escape occasionally

Fig. 3 shows a hydrogen atom consisting of a single proton and electron. Diameter of the electron orbit, which is diameter of the atom, is only 1/100,000,000 in. The nucleus diameter is only 1/10,000th of the electron-orbit diameter. So we see that an atom is mostly empty space with its mass concentrated in the incredibly small volume of the nucleus. Even to the scale drawn in Fig. 3 the diameter of the proton is 100 times *too large.*

In the combustion process, such as the burning of coal, we deal with a chemical reaction in which the electrons of the carbon and oxygen atoms undergo rearrangements that release heat, light and combustion products.

A nuclear reaction, on the other hand, involves the nucleus of the atom rather than the electrons. Here the cohesive forces holding the protons and neutrons together, *see p 88,* are enormously greater than the electrical forces holding the electrons in their orbits. Energy released when we split a uranium nucleus is tremendously greater than when we combine oxygen and carbon atoms. When completely fissioning one pound of uranium, the energy released equals that obtained from burning completely 2,600,000 lb of coal!

Nuclear fuel. Uranium is the only substance found in nature that fissions and propagates a nuclear chain reaction. In its pure form uranium is a heavy, hard, nickel-white metal, which oxidizes readily in air to a dark-blue metallic color. It occurs rather plentifully in the earth's crust, but unfortunately not in concentrated deposits like coal or iron ore. Known deposits lie principally in the Belgian Congo, Colorado Plateau and northern Canada. It may also be obtained as a byproduct of the gold-ore and phosphate industries.

Natural uranium contains three types (isotopes) of uranium: 99.3% of uranium-238; 0.7% of uranium-235; minute amounts of uranium-234. These differ only in the number of neutrons contained in the nucleus of their atoms.

	Protons	*Neutrons*	*Total (atomic mass)*
Uranium 234	92	142	234
Uranium 235	92	143	235
Uranium 238	92	146	238

Of these three isotopes, only uranium 235 is readily fissionable—that is, can split and release energy.

To use natural uranium as a fuel, it must be separated from its ore. The uranium compound then obtained must be highly purified to maintain a chain reaction. Next, the uranium compound must be reduced to a metal. Final fabrication shapes the metal to some convenient form for fueling the reactor where fissioning and energy release take place.

Nuclear fission. The fission process and chain reaction are fundamental to operating a nuclear reactor. A neutron has no charge and can penetrate into the nucleus of an atom without being affected by the negatively charged electrons or positively charged protons. If a neutron enters a mass of uranium and strikes the nucleus of a uranium-235 atom, there is a certain probability that the nucleus will split (fission), Fig. 4. This splitting will release the enormous amount of energy that bound the nucleus together to generate heat in the mass of uranium. In addition, the fissioned nucleus ejects two or three neutrons at high speed. These, in turn, charge through the uranium mass to hit and fission other nuclei, Fig. 5.

This chain reaction can proceed (1) at explosive speed with the number of ejected neutrons multiplying infinitely as in an atom bomb or (2) at a controlled rate with the released neutrons building up to a certain level and remaining there as in a reactor. An atom bomb, however, uses very concentrated U-235 extracted at great cost from natural uranium. A power reactor uses natural uranium, which contains only 0.7% of U-235 or natural uranium enriched with additional U-235.

With U-235 being the only *natural* fissionable material it would appear that only 0.7% (1 part in 140) of natural uranium can be used. The U-238, however, has an important characteristic. If it absorbs a stray neutron, it changes after a delay period of several days into a new element plutonium, which fissions just like U-235. Thus plutonium, not found in nature, is a man-made fissionable material. Also, U-238 can fission with neutrons of high energy level and contribute to the chain fission process to produce heat energy. This means that we can more nearly utilize all of the natural uranium as an energy source, not just one part in 140.

Fig. 4 shows the U-235 atom splitting into two new chemical elements (fission fragments) with the release of 2 or 3 neutrons, and energy in the form of heat and radiation. Therefore, in a nuclear reactor, the fuel is being constantly depleted and replaced by these "waste product" fission fragments. These can act as a "poison" to the reactor by wastefully absorbing neutrons and interfering with the chain reaction. Periodic processing of the fuel removes the accumulation of fission products to be replaced by additions of fresh fuel. The plutonium may also be removed in the process to be (1) put back in the reactor (2) used as a fuel for other reactors (3) used for weapons.

Breeding. With an average of 2.5 neutrons being given off per atom of U-235 fissioned, we can begin to see the possibilities of nuclear power. If one of these neutrons is captured by another U-235 atom, it fissions and releases neutrons to maintain the chain reaction. If another neutron is captured by a U-238 atom, it changes into plutonium eventually. Thus the plutonium atom replaces the U-235 atom destroyed in the previous fission. In other words, we manufacture fuel while we consume, Fig. 5.

With an average of 2.5 neutrons released per fission, we have one neutron to carry on the chain reaction and the others to produce plutonium from U-238. We can possibly manufacture more fuel than we consume! This is the so-called breeding process. It is possible to convert all fertile nonfissionable U-238 to plutonium for use in power production and weapons. This cannot go on indefinitely, of course, as eventually all the fertile material would be consumed, just as all coal and oil might eventually be used up. We can, however, vastly increase our supply of fissionable material while releasing a tremendous amount of energy.

All this sounds pretty fantastic, but it is not quite this easy to do. Technically there are enough neutrons given off per U-235 fission to make more than one atom of plutonium 239. But the excess is small and some neutrons are always lost to leakage out of the reactor and to absorption by nonfissionable reactor structural materials. Technical-design problems of a reactor are extremely rigorous, but breeding has been done on a small scale and is looked to as the reactor-design principle of the future.

Power reactor. Fig. 6 shows a schematic layout of a power reactor consisting of nuclear fuel, moderator, shielding, reflector, control rods and coolant passages.

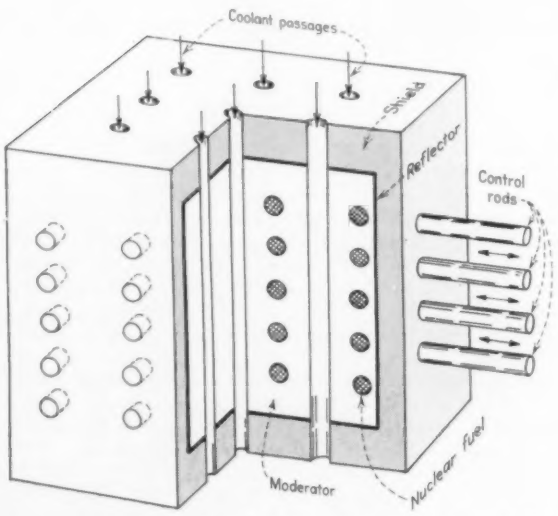
Reactor core consists of a mass of fissionable nuclear fuel, possibly diluted with nonfissionable material for nuclear reasons, desirable mechanical properties and economy, or a fertile material for the production of new fuel. The fissionable material would consist of one of the three presently known nuclear fuels: uranium 235, plutonium 239 and uranium 233. The latter is produced when a thorium 232 atom captures a neutron.

When the U-238 and Th-232 are bombarded by neutrons in a reactor they will absorb some of the neutrons and react to form the new man-made nuclear fuels, Pu-239 and U-233. These can both be fissioned by neutron bombardment.

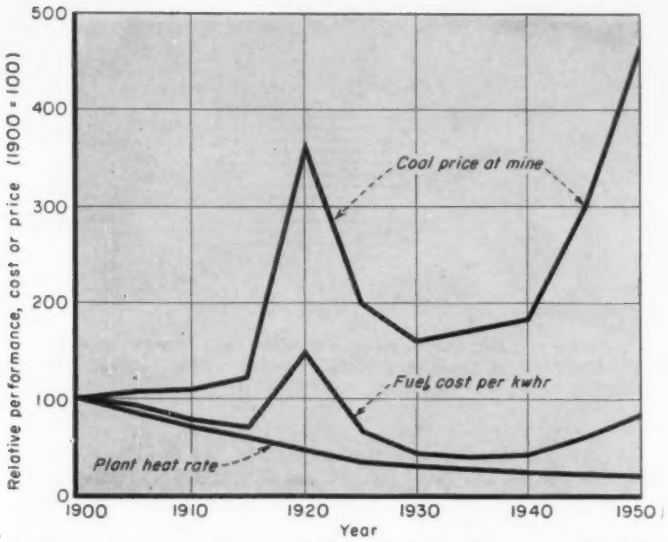
Recapitulating we find we have the following: Fissionable materials include U-235, Pu-239 and U-233, while fertile materials include U-238 and Th-232. These fissionable and fertile materials are all metallic elements and may be formed into a variety of shapes, such as tubes, sheets, rods, balls, powders, liquids, and so on, for use in reactors.

There are endless possibilities for reactor designs. Sizes range from that of a football to a good-sized house, in every conceivable geometrical shape.

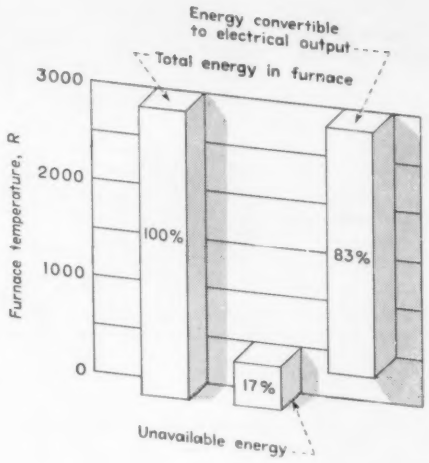
(*Continued on page* 220)



6 Power reactor might consist of nuclear fuel, held in moderator surrounded by reflector and shielding. Coolant flowing through passages carries off heat developed by fissioning. Control rods hold fissioning at desired rate by varying insertion



1 Decreasing average heat rates for U.S. power plants since 1900 has helped to offset the rising fuel prices in cost of electric power generation



2 The theoretical available energy at furnace temperatures is not realized in engines now

How will we lick superpressure problems?

Allure of efficiency gains by using superpressure steam is tempered by known and unknown obstacles that must be anticipated in plant design. Here's how a well-known consulting engineer sees them

By **THEODORE BAUMEISTER**
Stevens Professor of Mechanical Engineering
Columbia University
Consulting Engineer, General Public Utilities Corp

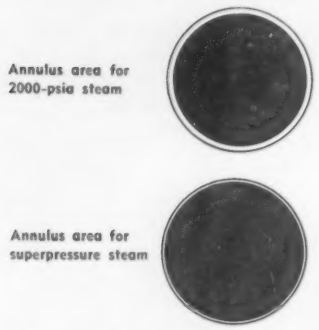
Dear Phil,

► YOUR REQUEST that I prepare an article for POWER on supercritical pressure application poses a challenge to anyone trying to better the methods and costs of power generation. We have all been tempted by other potentialities, such as nuclear fuels and the gas turbine, to believe that we may find other methods of generation than those currently used. We all recognize that existing methods will grow more and more antiquated and power engineers will find better methods in the future.

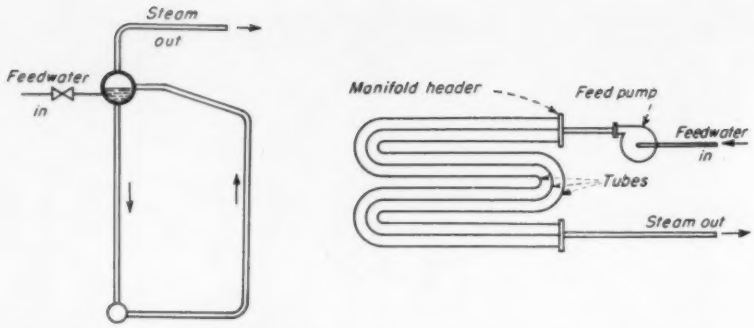
History shows the pattern. Before Watt and Newcomen, wind power—mills and ships, for example—was prevalent. Today, wind power is a curiosity. The reciprocating engine of Corliss, and even Stumpff, was made practically obsolete by the steam turbine. When will the cycle repeat itself to supersede the work of Curtis, Parsons and Rateau by new, unforeseen methods?

Hydropower is recognized as being inadequate for our immediate future growth and even public-power advocates today realize that fuel-generated power dominates. The TVA is not clamoring for more steam to control floods and navigation, but to meet power demands. This admits that steam power offers the only way to meet new loads.

With fossil fuels in the dominant position and with upward trends in the costs of fuel, labor and materials, we must find ways of reducing over-all costs to stimulate the use of more power. This may sound like a large order, but stopping to read the record, we can see the remarkable contributions that have been made to reducing the cost of power production. We cannot progress unless we are alert to every possible item of improvement. Fuel consumption per kwhr for steam plants of the utilities, Fig. 1, in 1952 was only 1/7 of that for 1900. Price of coal at the mine mouth has advanced over the same period by five or six times. The power engineer has more than offset the price advance for fuel and



3 High density of superpressure steam cuts 1st-stage pass to less than half



4 Absence of bubbling in superpressure steam eliminates need of drum used in a conventional boiler, *left*, allows simple forced flow controlled by feed pump

today the utilities produce a kwhr for ¾ of the fuel cost in 1900. This is a remarkable accomplishment and like most engineers we act like shrinking violets and modestly accept such results as of ordinary significance.

Instead of looking at the averages let's study best current practice. Today, we accept the range of 9000 Btu per kwhr as standard. We forget that in 1940 we could not break through 10,000 Btu per kwhr no matter how hard we struggled. Where do we go next? Do we stand here? Do we sit by and say we have gone as far as we can? Such a position signifies a dead mind —one that can visualize no further progress. Putting it thermodynamically, this position is identical with a dead universe where our heat has run down to absolute zero temperature and entropy has grown to infinity.

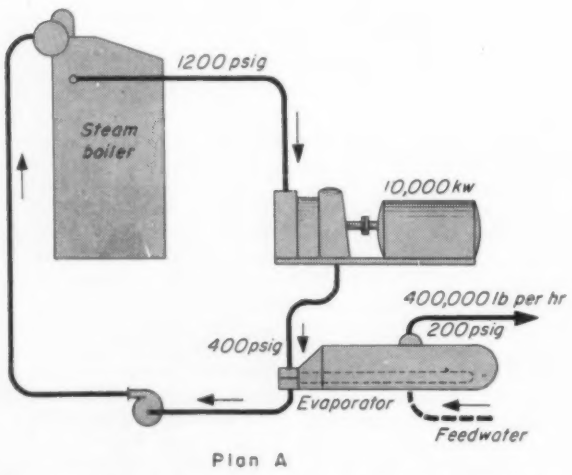
Target. Thermodynamically we are still far from the goal that we can approach. Thinking of our furnace temperatures of 2500 F and normal air temperatures, we can use the Carnot standard to judge the ultimate efficiency of heat conversion to electric energy. For 2500 F (3000 R approx) and 40 F (500 R) the limiting thermal efficiency is (3000-500)/3000 = 0.83 or 83%. This equals a heat rate of 3413/0.83 = 4100 Btu per kwhr, Fig. 2.

This goal shows that we might expect to develop a kwhr for 4000 Btu without changing our heat source. We make our fires with conventional fuels and get conventional temperatures. How can we approach this limiting efficiency with reliable machinery that will not impose an excessive economic burden in investment, labor and maintenance?

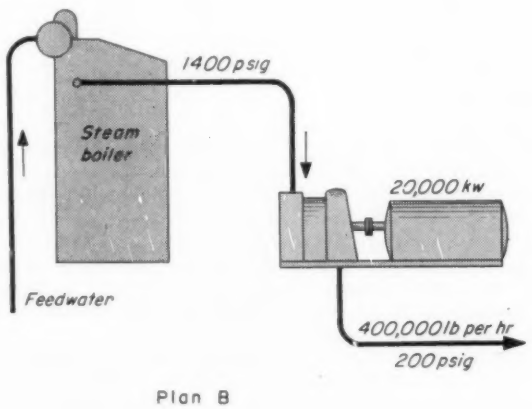
Several published studies cover the thermal prospects of the steam cycle if we postulate higher pressures and temperatures and multiple reheat. With steam conditions on the order of 10,000 psi and 1800 F and multiple reheats we enter the region of unabashed speculation. With such drastic proposals today we must consider the alternatives of gas turbines running on the closed cycle with thermodynamic fluids other than steam. Such proposals must be postponed until a later date. Before we can come to such extremes we will have to be satisfied with intermediate steps so that we can learn as we live.

I believe we will make progress slowly. This calls for a reasonable increase in pressure and temperature and possibly a second stage of reheat. Present boiler pressures range up to 2500 psi, some 700 psi below the critical. To go higher we might expect to run above the critical by a similar amount. This puts us in the region of 4000 psi. A concurrent extension in temperature would call for austenitic materials instead of ferritic, projecting us in the range of 1100 to 1200 F. A combination of these new limits would give us a potential over-all plant heat rate of 8500 Btu per kwhr. A second stage of reheat might lead to a further gain of 1 or 2% in fuel economy.

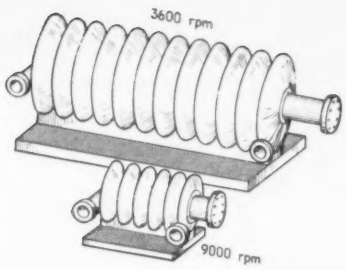
Viewing such figures in perspective,



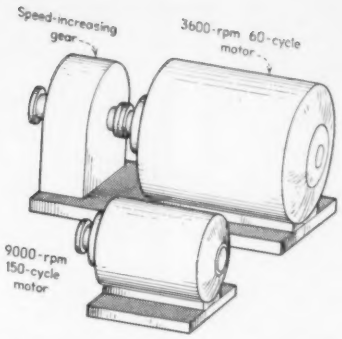
7 1200-psi turbine exhausts at 400 psi into evaporator to produce 400,000 lb of 200-psi steam and 10,000-kw power



8 1400-psi turbine exhausts 400,000 lb steam at 200 psi for process and generates an electrical output of 20,000 kw



5 Superpressure feed-pump sizes can be reduced by using higher shaft rpm



6 High-speed feed-pump drives need either stepup gear or high frequency

it won't be many years before the industry finds out how to work in this supercritical region. Progress will be slow and difficult because of the many new problems. These will have to be solved before we will have a commercially effective supercritical power plant. In the following, questions are asked to stimulate thinking. The list is not all inclusive. It will take the work of many engineers to find the answers. No one person or group has a monopoly on the answers. Some have thought more than others so they are noticeably ahead of the procession.

Size. How large will the units be? Turbine steam passages—nozzle and bucket sizes—at the high-pressure end will control. Blades less than $\frac{3}{8}$ or $\frac{1}{2}$ in. in height are unsuitable because the mean hydraulic radius is wrong, Fig. 3. Density of supercritical steam is at least double the density of steam now used. For the same stage efficiency we might need a unit of twice the kw capacity of one suitable for 2000 psi. Likewise, it is difficult to picture using partial circumferential admission. This raises further the minimum-size turbine that will give sustained internal efficiency. Does not this mean that supercritical pressures will demand turbines of at least double the kw minimum capacity used on present high-pressure units?

Boiler. What changes will have to be made in boiler designs to adapt them to supercritical pressures? It is often said that above the critical there is no difference between the liquid and vapor states of a fluid. Put another way, the critical point is defined as the maximum temperature at which a gas can be liquefied by applying pressure.

For water the critical conditions are 705 F and 3206 psi, approximately. The latent heat is zero. With no change of state above 3200 psi, the water level in a boiler gage glass disappears. The boiler drum can be eliminated. Separation of steam bubbles from the water is no longer a problem. The boiler actually becomes a sensible-heat exchanger, one part a direct-fired "economizer" and the rest a direct-fired "superheater." A continuous tube, in effect, should serve for making hot steam from colder feedwater, Fig. 4.

Like any direct-fired liquid heater we must have a pump to push the fluid through the system. Our "boiler" no longer relies on natural convection currents for circulation, but must use a pump to give positive circulation.

Under this broad specification our "boiler" may use a furnace and firing system of conventional form with auxiliaries like air heaters, safety valves, insulated casing, forced- and induced-draft fans. Will not the designer be given an opportunity to alter our thinking so large boilers no longer need be 10 or 15 stories high, but rather built bungalow style? This could alter our ideas on indoor vs outdoor plants.

Feed pump. With a forced-circulation "boiler," must not the feed pump assume duties well beyond the usual scope? There is no mass of liquid stored in the circulating system. Whatever enters the "boiler" as water must promptly leave as steam in a continuous, uninterrupted stream from pump to turbine throttle. The pump must be very sensitive to changes in steam demand. It must follow immediately any changes in steam demand and maintain desired pressure.

Is not the centrifugal pump ideal for this purpose? But how many stages will be needed to develop 5000 to 10,000 psi at discharge? What steps can be taken to reduce the pump size? It is almost self-evident that we must abandon our usual limitations of 3600 rpm and expect higher speeds to reduce the number of stages, Fig. 5. How fast

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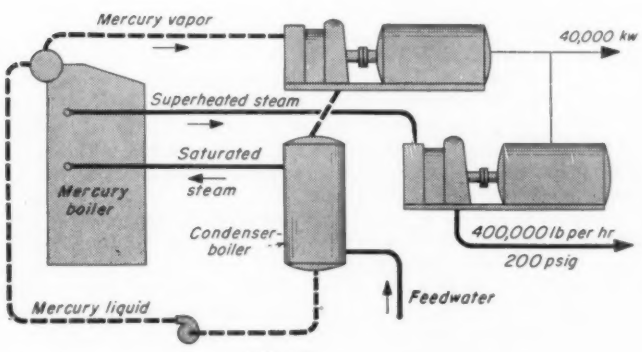
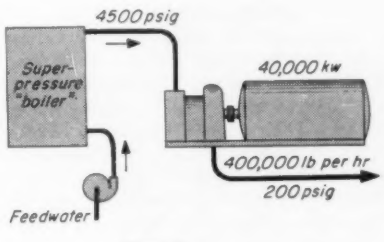


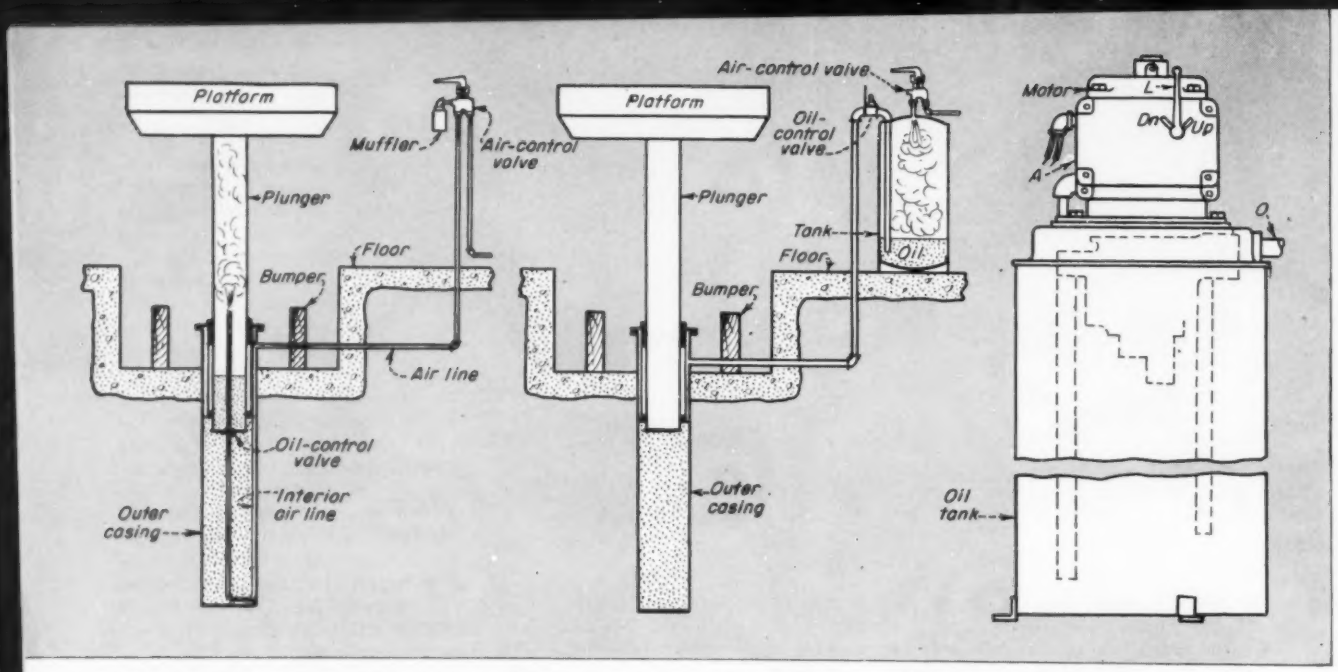
Plan C

9 Mercury-vapor turbine exhausts into condenser-boiler to generate 400,000 lb of 200-psi steam and 40,000-kw power



Plan D

10 Superpressure turbine exhausts 400,000 lb of steam at 200 psi for process and also generates 40,000-kw output



1 In this air-oil unit, lifting is done by compressed air on elevator plunger

2 Here, air-oil lift oil-locks the car at landings when elevator is stopped

3 Lever-controlled power unit, for low-capacity lifts, mounts on the oil tank

Oil-powered units insure reliability of...

Modern electric-hydraulic elevators, lifts

Here is a timely report by F A Annett, Contributing Editor, on several power units and their control schemes, as used in the fast-growing field of electric-hydraulic elevators

► POWER UNIT and its control form the heart of all electric-hydraulic elevators and lifts. These key units vary in complexity. Probably the simplest are those used in conjunction with manually controlled air-hydraulic automobile lifts in garages. Automatic self-leveling passenger or freight elevators have an electric-motor-driven pump, plus the valves necessary for smooth elevator movement, all actuated through pushbuttons.

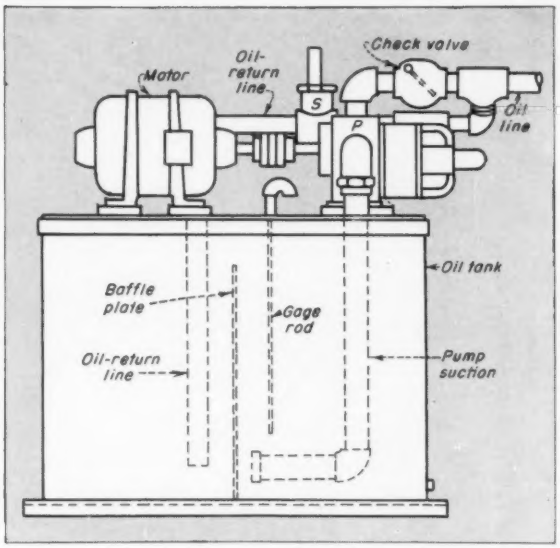
Air hydraulic. Fig. 1 diagrams one design of air-oil mechanism used chiefly for automobile lifts. A compressed-air line comes into top of cylinder casing, drops to the bottom, then up into the plunger. Casing is filled with oil. Plunger bottom is closed except for clearance holes for air pipe and control valve.

Why use oil? Well, by filling the casing with oil, Fig. 1, the air volume needed to operate the lift is less than 50% of that required without oil. Oil also shortens the air column making the unit less likely to change level with load. Further, oil serves as a safety measure since the lift cannot rise or lower faster than the time it takes for oil to flow through control valve in plunger bottom. Lift could be raised at light load and dropped at heavy load at a much faster rate were it not for the oil-control valve in plunger bottom. Control valve holds speed to a safe value in either direction of travel.

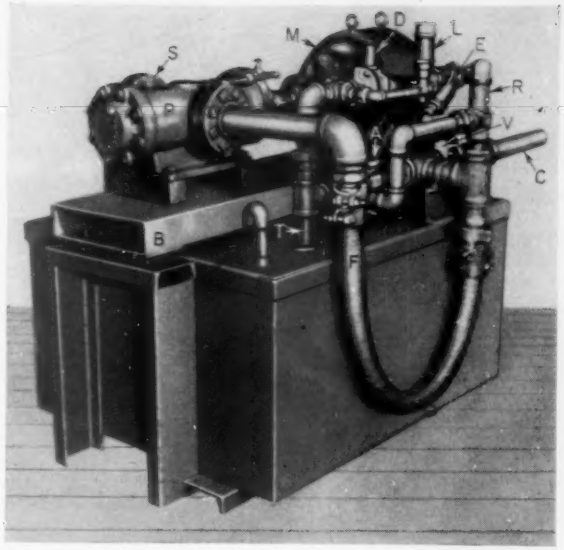
Compressed air. In this same unit, Fig. 1, a lever-operated valve controls flow of compressed air to and from the jack. Air is admitted to the plunger by lifting the control-valve handle. Pressing down the lever opens the discharge valve in the control unit, releasing air through the muffler, thus allowing the load to lower. With lever in neutral position, both the admitting and discharge valves close, stopping the lift and its load.

Since air is elastic the lift hunts up and down slightly as load changes. It is mainly for this reason that the unit has limited application outside of automobile lifts. The system is used to a limited extent in industry for machine-feed applications where a slight upward float helps keep load level with the feed table.

Oil-lock system. Compressed air is the power medium, with oil making direct contact with piston in the system, Fig. 2. Here, with lift at lower landing, most of the oil is in the pressure tank. Atop the tank is a compressed-air control valve. An oil control is located in the jack line. When the compressed-air admission valve and the oil valves are



4 Power unit for medium-size lifts has constant-speed motor driving a rotary pump, along with suitable control valves



5 This passenger-elevator power unit has a quiet-operating triple-screw rotary pump supplying a smooth flow of oil

opened, air pressure forces oil from the tank into the casing around plunger.

Releasing the dead-man oil-control valve locks the system, leaving the load supported on the oil column. The load assumes a fixed position. To lower lift, air is exhausted from tank through a muffler, *not shown,* and the oil valve is opened.

Where used. Operation of hydraulic lifts with compressed air is usually practical only where an air supply of 90 psi or higher is available. Even then it is recommended for limited use, generally where less than five trips are made per hour, or where speed is not a major factor.

It is seldom economical to use compressed air for large lifts. Air cost is maybe ten times that for power taken by an electric motor driving an oil pump. Once again, where operating speed is a factor, don't use compressed air. Even though the plunger will move at speed comparable to that of an oil-powered unit, considerable time is lost in charging and discharging air when moving the lift.

Outside the air-oil lift applications mentioned above, most hydraulic lifts and elevators are operated by an oil-power unit. These units consist of a motor-driven pump, an oil reservoir, and a system of valves for controlling oil flow to and from the plunger casing. Pumps used in these units are generally the positive-displacement type, either the rotary or rotary-piston designs.

Small power units. Simple lever-controlled power unit for low-capacity lifts is shown in Fig. 3. It consists of a vertical motor driving a gear-type rotary pump mounted in the top of an oil tank. Valves, controlling oil flow to and from hydraulic cylinder and lift plunger, are also in top of tank. Control assembly *A*, actuated by lever *L*, is mounted alongside the motor. Pump is rated 28 gpm at 185 psi. Tank capacity is 32 or 75 gpm depending on lift rating. Moving lever to right starts the pump and opens oil intake and discharge valves. Oil is discharged through pipe *O* to the lift cylinder raising the load.

When lever *L* is released it automatically comes to the center or neutral position stopping the pump and closing the check valve. This valve operation oil-locks the lift in position. Movement of lever to the left opens a valve, letting oil flow from the plunger cylinder back into the tank through pipe *O*, lowering the lift.

Larger units. Hydraulic equipment, for a larger lift than that discussed above, is shown in Fig. 4. It consists of a horizontal-shaft constant-speed motor coupled to a gear-type rotary pump *P* having a built-in pressure-relief valve. Pump discharges through a check-valve into an oil line leading to the lift's hydraulic cylinder. This check valve oil-locks the lift in the position it is in when the pump stops.

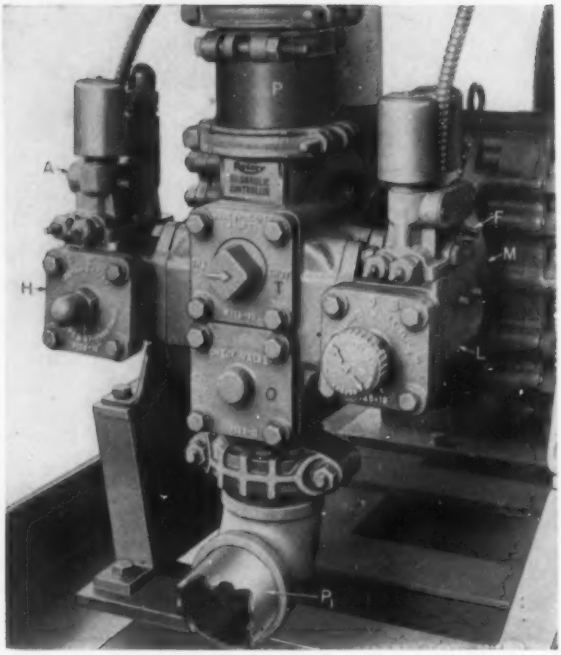
This arrangement of electric-motor-driven pump and valves is basic to all hydraulic-lift and elevator power units. On all power units the pump discharges through a check-valve. In that way, when the pump stops, the lift or elevator car is oil-locked in position. A solenoid valve *S* bypasses the check valve to lower the car or lift. Solenoid valve opening is sized to limit down movement of lift or elevator car to a safe value. A pressure-relief valve is either built into the pump or installed in the connecting piping.

Limit switches. On all electric elevators, limit switches and other safety devices must be provided to prevent the car or counterweight from being pulled into the overhead structure. If such an accident were to happen on a drum-type machine, a serious wreck would result. Limit switches guard against just such an accident. However, hydraulic lifts and elevators have no such hazards.

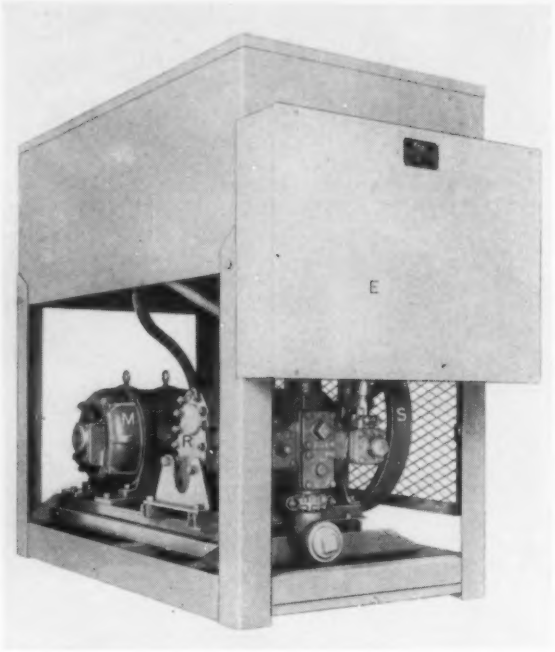
As an example, the hydraulic lift does not require terminal-floor limits. Speed is so low that even if the operator ran the lift to the limit of up-travel, plunger bottom would hit the cylinder head and stop. Then even if pump continued to run, the relief valve would open on a small pressure excess, bypassing the oil back to storage tank with no resulting harm. If the operator is daydreaming and permits the car to go beyond normal limits, pump noise and relief-valve popping will rouse him quickly.

If solenoid valve is held open when lowering, the loaded lift can only go down until it rests on the bumpers or the plunger hits cylinder bottom. In either case, the speed is so low that no harm is done. For these reasons, control of hydraulic lifts may be stripped to the bare essentials.

Control refinements. For passenger



6 Valve assembly unit in this design responds to signal from an electric panel that is actuated from pushbutton stations



7 Valve assembly here mounts on suction and discharge of a rotary piston pump. Oil tank is atop the steel enclosure

and freight elevator service the control requires a few more refinements than are needed for the simple lift. Such a power unit, as built by the Globe Hoist Co, is shown in Fig. 5. A triple-screw pump *P* driven by a squirrel-cage motor *M* is used for quiet operation. Pump produces a smooth oil flow without pulsations. Both pump and motor are mounted on a heavy structural-steel base *B*, separate from the oil-storage tank. A rubber coupling and rubber sound-insulating mounts reduce noise transmission from motor and pump.

Pumping unit. On this same unit, Fig. 5, suction *S* is on the left of the pump and discharge on the right. A 5-ft length of flexible tubing *F* connects the pump's discharge to solid-piping manifold. This manifold includes the control and other valves. Pipe *C* runs to the elevator's hydraulic cylinder. Check valve *V* oil-locks the elevator car in position.

In case of over-pressure, relief valve *R* bypasses oil back into the oil-return line and the tank at *T*. Return line connects into the hydraulic cylinder line beyond the check valve. From there the oil travels up through a strainer *E*, to down control-valve *D*, and into the tank at *T*. Note the return-line connection into the cylinder line is hidden behind relief valve *R*.

Down-valve *D* is bypassed by leveling valve *L*. This valve is controlled by a switch near the landing actuated by a car cam. Accelerating valve *A* serves to accelerate the car smoothly upward by relieving the shock of suddenly starting the pump.

Starting and stopping. Power unit is controlled by pushbuttons at the landings or in the car. When an up button is pressed the motor starts, accelerating the pump. When the pump starts, its discharge is bypassed back through valve *A* to the oil reservoir. As valve *A* closes slowly, oil is directed into the hydraulic cylinder accelerating the car smoothly. When the accelerating valve closes, full pump discharge goes to the hydraulic cylinder and the car runs at rated speed.

When the pump is stopped, the car comes to rest slightly above the floor to which it was signaled. A car cam then closes the leveling switch. This switch opens the leveling valve permitting oil to flow slowly from the jack cylinder. Flow from the cylinder brings the car back to the floor where cam releases the leveling switch, closing the leveling valve.

Down operation. When a down pushbutton is pressed, control valve *D* opens. The opening of this valve lets oil flow from the jack back to the reservoir. Car and its load lower by gravity until down-valve closes. Control for this valve is arranged so it closes when the car is slightly above the floor where it is to stop. Then the leveling valve opens bringing the car level to the floor. The leveling valve then closes.

Valve assembly unit for a *Rotary Lift* hydraulic control is shown in Fig. 6. It carries out the "instructions" from electric control panel, which is actuated by the operating pushbuttons. This unit is a combination of eight control valves. External piping consists of *P* leading to the oil-storage reservoir, and P_1 going to the jack cylinder. All valves are externally adjustable without removing the unit from the system.

The valve unit is mounted directly on suction and discharge of a rotary-piston, Fig. 7. Complete assembly is enclosed in a steel housing with an oil storage tank on top. Separate cabinet *E* houses an electric control panel. It may be mounted on either end of the steel housing or on an adjacent wall. The pump is driven by a squirrel-cage motor *M*, V-belted to large sheave *S* on the pump drive shaft.

Units of the above type are built in ratings of 5 to 80 hp for freight elevators handling loads to 100,000 lb and car speeds to 100 fpm. For lighter-duty lower-speed elevators, a motor-driven helical-gear pump is used. It is incorporated in power units of 3 to 7.5 hp, mounted on a steel frame floating on a vibration-absorbing mounting.

Valve operation. The valve assembly,

(*Continued on page* 212)

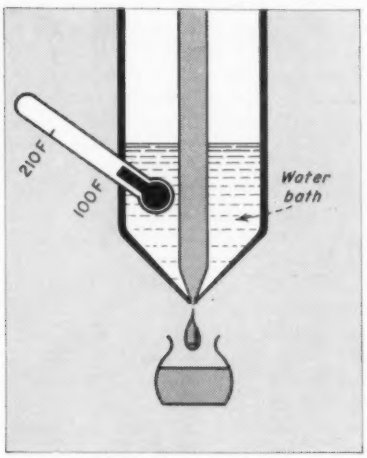
Hydraulic oil . . . today

Oil hydraulics is continuing to find new applications throughout industry. One of the more recent is in electric-hydraulic elevators and lifts, pp 96-98 of this issue. Highlighted here are the seven major factors to consider in selecting a hydraulic oil for today's machines.

Briefly, to do its job hydraulic oil must hold viscosity fairly steady over a wide temperature range. It must resist the effect of air oxidation. Its lubricating ability (oiliness) must hold wear to a minimum on all close-fitting parts. Water that finds its way into the system must separate out quickly. Oil foaming must be kept to a minimum.

Information in this article is taken from the booklet, *Industrial Oil Hydraulics*, published by the Cities Service Oil Co.

VISCOSITY, carefully chosen, reduces wear and allows free oil flow



TIME NEEDED for 60 cc of oil to flow is viscosity of the sample in Saybolt sec

Most important single physical property of any lubricating oil is its viscosity. Simply stated, viscosity measures an oil's resistance to flow. Hydraulic oil must have correct viscosity at the operating temperature, and the ability to flow readily to various parts of the hydraulic system at a desired rate.

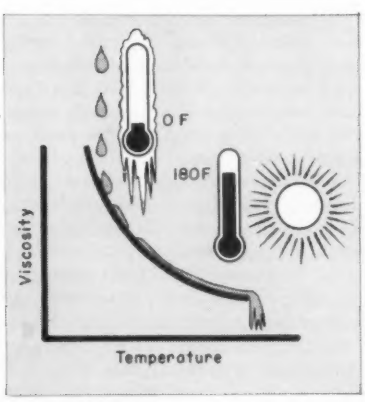
In brief, proper viscosity is a balance between (1) an oil with a high enough viscosity to hold wear to a minimum and reduce internal leakage and (2) one with a viscosity low enough to permit it to flow readily through the system.

Viscosity of lubricating oils in this country is generally measured by Saybolt Universal Viscosimeter, *left*. In essence it consists of a cylinder, holding oil sample, fitted at bottom with a small orifice closed by a cork stopper. Cylinder is surrounded by a constant temperature bath.

When oil sample reaches the test temperature (normally 100 F for hydraulic oils) the cork is removed. Time in seconds required for 60 cc of oil to flow into a standard flask is viscosity at bath temperature and is expressed as Saybolt Universal Seconds, sus.

Oil viscosity decreases with temperature rise and changes more in some oil types than in others. For this reason, consider operating temperature when selecting proper hydraulic oils. Thus, where a variable-discharge pump continually reverses its suction and discharge, the same oil passes back and forth through the pump with little oil drawn from reservoir. Here oil temperature at pump is more important than in reservoir or other parts of the system.

VISCOSITY INDEX is measure of viscosity change with temperature



TEMPERATURE effect on oil's viscosity is a measure of its viscosity index, VI

Oil viscosity changes with temperature. As mentioned above, it changes more in some oils than in others. The measure of rate of viscosity change over a range of temperatures is termed viscosity index (VI). Example: if oil becomes thick at low temperatures and extremely thin at high, it has a low VI. But, if viscosity shows relatively little change with variations in temperature, oil has a high-viscosity index, or as commonly referred to, a high VI.

An ideal hydraulic oil would hold viscosity steady at all temperatures. However, there is no such oil. But many oils either inherently or through use of additives show a minimum viscosity change over a wide temperature range. Such oils reduce the warm-up period where others might cause sluggish machine operation.

VI is of little importance where temperature variation is small. But it does become important as temperature ranges spread farther apart. And where different parts of a machine operate at widely differing temperatures, oil viscosity must be adequate at all points in the hydraulic system.

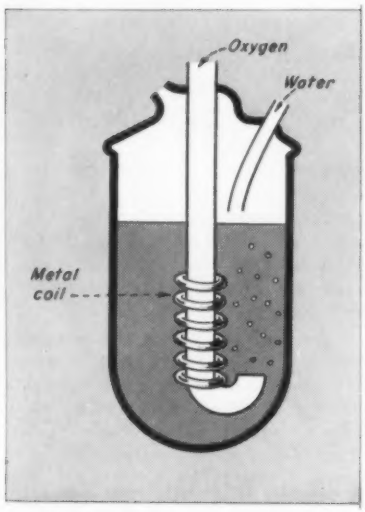
In hydraulic systems the least amount an oil thins out over a temperature range, the more efficiently it operates. High VI, therefore, is desirable in a hydraulic oil and leading manufacturers of hydraulic equipment usually include this specification in their instruction booklet accompanying a new machine. (*Continued on page* 100)

THE JOB hydraulic oil does is twofold: it must transmit and control power doing the work, besides lubricating all moving parts of the pump and other mechanisms in the hydraulic system. Suitability of hydraulic oil for some specific machine can only be determined by performance testing.

The reputable oil supplier performance-tests his products in the laboratory and later in the field. Using such performance data as background he produces branded products for specific jobs and stands behind them with his name and reputation.

It's fundamental that hydraulic oil must be of good quality. Further, it should possess the characteristics to yield top performance where used under severe conditions. Under such operation a topnotch hydraulic oil is more economical despite the higher initial cost.

OXIDATION RESISTANCE increases the service life of your oil



OXIDATION TEST is practical indication of the service life in a hydraulic oil

Hydraulic oils, particularly under severe service, are prone to combine with oxygen and when they do, they decompose. This chemical change, termed oil oxidation, results in formation of organic acids that are harmful to vital parts in a hydraulic system. This alone can shorten machine life materially.

Oxygen reacts with oil to form sludge as well. This action is speeded up by some metals, water, high temperatures. Conditions in many hydraulic systems are ideal for oil oxidation, because of contact with air or water. Outside contaminants, like metallic particles, dust, dirt, tend to accelerate hydraulic-oil oxidation unless care is taken to keep the system clean.

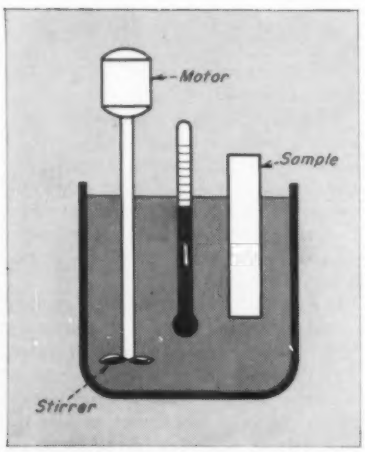
So hydraulic oils are carefully refined to offer maximum resistance to oxidation or other chemical change, when subjected to above conditions.

A number of tests have been devised to evaluate oxidation resistance of petroleum oils. Most generally accepted oxidation test for hydraulic oils is shown schematically, *left*.

In this method oxygen comes in intimate contact with oil in presence of water and an iron-copper catalyst at 203 F for a specific period. Results are reported as time in hours the test is run before the acid or neutralization number of the sample reaches a prescribed value. A refined straight-mineral oil should take about 75 hr to reach neutralization number of 2.0. But it is not unusual for inhibited oil to reach 1500 hr or more.

Oil oxidation rate depends greatly on the crude from which it is derived and the method and efficiency of refining. By using chemical additives, rate of oxidation of petroleum oils is materially reduced and controlled. Such additives, termed oxidation inhibitors, are important in modern hydraulic oils.

RUST PROTECTION, built into oil, will guard machine parts



OIL IS HELD at 140 F during this test. Sample is then checked for signs of rust

Rust is simply an accumulation of ferrous-metal oxide. It is a process of adding to metal; oxygen plus base metal. Corrosion is an eating away or pitting of the surface. Rust, if present in a hydraulic system, is generally found in the reservoir, although it can form in other parts of the system.

Efficient, troublefree operation of a hydraulic system cannot be expected where vital parts corrode and rust. Corrosion, resulting from products of oil oxidation, gradually deteriorates closely fitting parts to where their action is retarded. This leads to excessive leakage, and operation becomes inefficient, sluggish.

Rusting of ferrous-metal parts in a hydraulic system, by action of oxygen and water, affects operating smoothness and materially reduces service life.

It is important, then, that oils for hydraulic service have the ability to prevent corrosion and rusting under all conditions. Oil technologists, again with their chemical magic, have developed additives. When added to a top-quality hydraulic oil, they keep corrosion and rust on vital working parts to a negligible minimum.

A laboratory test to evaluate effectiveness of a rust-inhibited hydraulic oil is shown schematically, *left*. In this test a polished metal strip is immersed in oil test-sample at 140 F, carefully maintained. The sample, to which water was added, is continually stirred mechanically during test. After a predetermined time, metal strip is studied for rusting. If visual inspections show no rust, the inhibited hydraulic oil has passed the laboratory test.

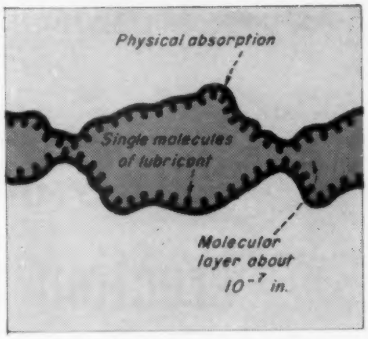
OILINESS reduces friction, cuts wear between close-fitting surfaces

Where clearances are large, as between shaft and bearings in steam turbines, the only bearing friction, while machines are running, is oil's internal friction. This friction depends directly on viscosity. But the picture changes abruptly with hydraulics.

Modern hydraulic pumps are precision made, their rubbing surfaces are ground to close tolerances for minimum oil leakage and for maintaining maximum pump efficiency. Under these conditions a state of *thin-film*, or *boundary* lubrication exists, and some metal-to-metal contact may be expected.

For proper lubrication a hydraulic oil must possess good *oiliness* properties. This means it must hold to a minimum the coefficient of friction between close-fitting surfaces. Sketch, *right*, is enlarged view of two metal surfaces in contact. Well-machined surfaces appear smooth to the eye, but under a microscope look like a series of hills and valleys. Oil with poor oiliness properties may fail to keep these surfaces separated under load leading to wear from metal-to-metal contact.

For practical purposes look upon oiliness as the property that causes a reduction in friction and wear in thin-oil-film region.



SMOOTH TO EYE—but a fine-ground steel edge looks like this under miscroscope

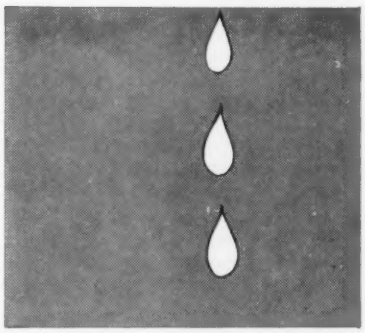
WATER must be separated readily from oil to prevent emulsions

Contrary to popular belief, water and oil mix when whipped together to form an emulsion. Water speeds up harmful chemical changes in oil. In the typical emulsion in hydraulic oils (with water in the system) each water particle is surrounded by oil. To reduce harmful effect of water and oil emulsions, a hydraulic oil should cast off the water or settle out the emulsified oil fast.

In addition to the harmful chemical changes mentioned, a water emulsion may have a slimy consistency or be sticky or pasty. Such an emulsion interferes with normal operation of control valves and other components of the hydraulic system where clearances and adjustments are close.

Where soluble oils are used for cutting or grinding (on hydraulically operated machines) avoid serious trouble by keeping soluble oil emulsion out of hydraulic system. Once it mixes with the hydraulic oil it is difficult to separate the two because of the emulsifiers contained in soluble oil.

Oil-oxidation products have a strong affinity for water. The more an oil is oxidized in service, the more water it can pick up. Where pickup may be appreciable, it is doubly important that oil have high oxidation resistance.



DEMULSIBILITY test tells if hydraulic oil has ability to separate quickly from water

FOAMING leads to erratic hydraulic-machine operation and oil waste

A frequent difficulty in the operation of hydraulic systems is the formation of foam, which results from the constant pumping or churning action of oil. This condition occurs, also, when the oil return line is not kept below the oil surface at all times, or when oil in the reservoir is allowed to drop too low. In many systems, turbulence and mixing of oil with air are difficult to avoid, and foaming becomes a serious problem in machine operation.

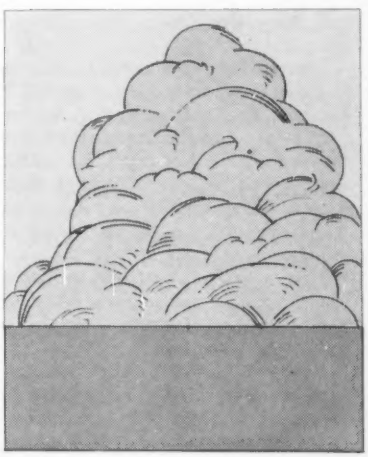
It must be remembered that the fundamental principle of operation in any hydraulic system is based on the fact that hydraulic oil is essentially incompressible. This condition no longer holds true when the hydraulic system of a piece of equipment contains free air.

Air that enters the system is soluble in oil. When the oil pressure increases, more air is held in solution. Air in solution with oil does not affect its compressibility, and the air will remain in solution just as long as the oil is under pressure.

As this pressure is relieved, the air appears as free bubbles, and it is these bubbles, or foam, that are detrimental to cylinders, valves and lines. Oil containing foam is no longer incompressible, resulting in erratic and inefficient machine operation.

Foaming is particularly objectionable in the operation of fluid couplings and torque converters because low air-weight lessens the impact energy that can be obtained from a given volume of foamed oil. This may affect operation.

Modern hydraulic oils are fortified with suitable inhibitors to minimize the formation of foam.



OIL-FOAM mixture is compressible, so may cause erratic operation of machine

HOW TO ORGANIZE YOUR NEW POWER PLANT—8

Here's an A-1 way to handle boiler erection and preliminary inspection

Good boiler design must be followed by proper erection and careful inspection before the unit can be started up safely. Follow this step-by-step procedure to insure a workable setup

By D C SWIFT, *Ebasco Services Incorporated*

► THE MAIN POINT to remember in erection, inspection and operation is that a boiler is first and foremost a pressure vessel. All work must be done with great care to insure safety. The procedures outlined here serve as a check list on sequence of operations for an expertly erected boiler.

Packaged boilers. Small-sized boilers are often assembled in the manufacturer's shop. After testing they are shipped as complete units. With oil firing, even the controls may be set and adjusted at the factory. Essentially, erection work consists of mounting boiler on a suitable foundation and connecting up electricity, feedwater, steam and blowdown lines, air-supply and flue-gas ducts.

Larger-sized units must be shipped in parts, then assembled and erected on the job. The massive steel framework may or may not be incorporated with the rest of the building steel, but in any case it is erected before boiler drums, tubes, superheater and economizer elements can be set up for assembly.

First step in actual erection is to level drums. Then, properly space and align tubes and elements. Next, roll or weld them into place.

Hydrostatic test. After pressure parts are assembled, arrange for a hydrostatic test at 50% above normal maximum design pressure. It is best to do this before applying refractory to the boiler, as you then detect and repair leaks more easily.

During cold weather, take precautions against freezing after the hydrostatic test. Drain the boiler, or heat it enough to keep it warm.

When unit is tight and has been approved by the insurance inspector, proceed with erecting the refractory and furnace enclosure, and applying the casing. General practice is either to use a grease or tar coating on the tubes or to put in some form of paper spacer between steel and refractory. Thus tubes and refractory are not bound together so as to restrict expansion of either.

Boiler casing must always be substantially air-tight, and a pressure-fired unit requires an almost perfectly air-tight casing to avoid trouble. Make an air-pressure test, using forced-draft fans only, and titanium-tetrachloride smoke to indicate leakage points.

With hydrostatic test satisfactorily completed, install safety valves and other flanged attachments. Flange faces should be clean and undamaged, or later trouble with gasket joints is likely. Check carefully to see that thermal expansion is not restricted. Support piping and connections so they are free to move with boiler or superheater.

Next, test all tubes with a ball, air or other effective means, to be sure none are plugged.

If drum is to be acid-cleaned before operation, you can lay its internals in the drum bottom until cleaning is completed. When you finally make the installation, be sure drum internals are level and properly placed, and that gaskets and welded joints are leakproof. If this is not done, you will probably have trouble with poor-quality steam.

When construction is essentially complete, clean boiler of all dirt and debris on both fire and water sides. Remove all wood, cardboard or other flammable material, to avoid possibility of a glowing ember causing an explosion during start up.

Before you actually operate the boiler, you must install, align, lubricate and try out the various auxiliaries, including soot blowers, stokers or other fuel preparation and burning equipment, draft equipment and connections, instruments, dust collectors, feedwater pumps, heaters and regulators.

Protection before start up. If you complete erection of boiler and setting some time before start up, take precautions against internal and external corrosion, much as you would use the dry method to lay up a boiler.

If hydrostatic test has filled superheater tubes of nondrainable type with water, you can blow it out by draining the boiler, closing it up tight, applying air pressure up to 100 psi, or the maximum available if it does not exceed boiler-pressure rating.

Blow out air and water in the superheater through the main steam lead,

which has been disconnected at some point to provide a large free opening. You can use the stop valve in the boiler lead or the nonreturn valve at the boiler to control the blow to safe proportions. A heavy air flow assures that all tubes are blown free of dirt.

Refill the boiler with air and blow out the superheater several times to assure removal of water that drains down into the bottom loops after the first blow.

Take proper precautions to prevent damage from dirty water and air. For this preliminary superheater drainage you can often use the venting arrangement that will later blow out the main steam lead from the boiler.

Best way to protect internal boiler surfaces during prolonged idleness is to drain completely and then dry water from all pockets and low places. Next, place trays of quicklime in the drums to absorb remaining water vapor, and tightly close up the boiler.

Protection of outer surfaces depends on boiler design and climatic conditions. Keep rain out of the setting as much as possible. A restricted air circulation generally allows less rusting than a free flow, particularly in warm weather.

If boiler is to be laid up only a short time, you may add a sodium sulfite solution to the water in the drum, then completely fill the unit with water, excluding all air. Some operators put an expansion pot atop a drum vent. This provides a reserve supply of liquid to take care of small leaks or changes in volume because of expansion or contraction.

Inspection before boil-out. Thoroughly check boiler, setting, auxiliaries and all connections after erection is complete and before beginning dry-out and boil-out.

Remove debris and dirt inside of the drums. Then give boiler a preliminary flush and blowdown to reduce amount of silica remaining to be absorbed in boiler water.

Unless boiler is to be acid-cleaned or given a protective surface coating, the drum internals should all be in place with gaskets properly installed and joints tightly made up. Tubes covered by steam-separating equipment should be checked for obstructions before this equipment is installed.

Run drains from steam separators or traps to assure sealing and prevent drain flow reversal under load. Check water columns to see that their center lines are set to correspond with the normal operating level in boiler drum, as specified by the manufacturer. Also, be sure expansion of the boiler will not affect indicated water level.

Inspect piping to columns to see that (1) it is properly supported and (2) drain lines from column and gage glasses are connected up. You may want to install temporary round glasses for boiling out high-pressure boilers, because the alkaline solution used rapidly eats the mica in high-pressure gage glasses.

As safety-valve openings are often blind-flanged during hydrostatic tests, be sure openings to all valves and connections are free and clear. Inspect steam and water sampling, continuous blowdown and chemical feed lines; see that pressure-gage lines are completed and valves open. Decide on location for a test gage for setting safety valves. Calibrate all gages and correct for static head.

Inspect boiler and waterwall supports to see that these parts are properly supported, free to move, and have sufficient room for expansion as the boiler is brought up to pressure. It's a good precaution to establish gage marks at a number of points to permit measuring expansion of boiler and waterwalls.

Setting. See that workmanship in furnace and boiler setting is good, and that there is proper room for expansion of brickwork and boiler parts. Test baffles for tightness and location. Check placing and arrangement of test openings for observation, sampling and instrument operation.

Remove all wood, cardboard or other combustible material, to prevent possible explosion of pocketed gas while this combustible is glowing. Make a smoke test with a light pressure in the furnace, to check tightness of the setting. Use wood or titanium-tetrachloride smoke.

Also, check soot blowers for arc of operation and proper hot setting under operating temperatures, to avoid steam impingement on baffles or tubes.

Air and gas equipment. Examine air and gas dampers to be sure they operate freely and close tight, yet have enough clearance to assure against binding when hot. Have "open" and "closed" positions plainly marked, and provide convenient means for operating and securing the dampers in any desired position.

Inspect air and flue-gas ducts to insure that they are clean and free from obstruction. Provide an air supply to the furnace during boil-out. In warm weather, you may have to build a small fire in the base of the stack to get the gas moving.

If a fairly high stack is available, you can probably bypass the induced-draft fan or let the gas pass through the idle fan during boil-out. However, if you plan to run the induced-draft fan, line it up, check for rotation and means of control, and lubricate it. Take similar steps for a regenerative air heater, if it is to be run. This type air heater is sometimes operated during boil-out runs, after flue-gas temperature reaches 350 F.

Piping. Check blowoff lines to see that they are completed and can be blown without danger to anyone. Steam valves and piping on the drains or superheated and saturated steam headers, and all other lines connected with the boiler and main steam lead, should be checked for completeness and readiness for operation.

Inspect safety-valve discharge piping, dish ells and drain piping. Valves must be in place, properly supported, and with proper clearance so body does not touch discharge piping when boiler is either cold or hot, but especially when it is hot.

Be absolutely sure safety-valve vent piping is clear, free of any obstruction and firmly supported. Check all piping for expansion provisions. Cast-iron plugs, which are dangerous under high pressure, should be replaced with steel ones before starting operation.

Water and chemical feed. Provide for a properly valved and controlled feedwater supply with enough pressure to force it into the boiler at maximum boil-out pressure. Also, if you plan to use chemical feed pumps, get them ready and try them out.

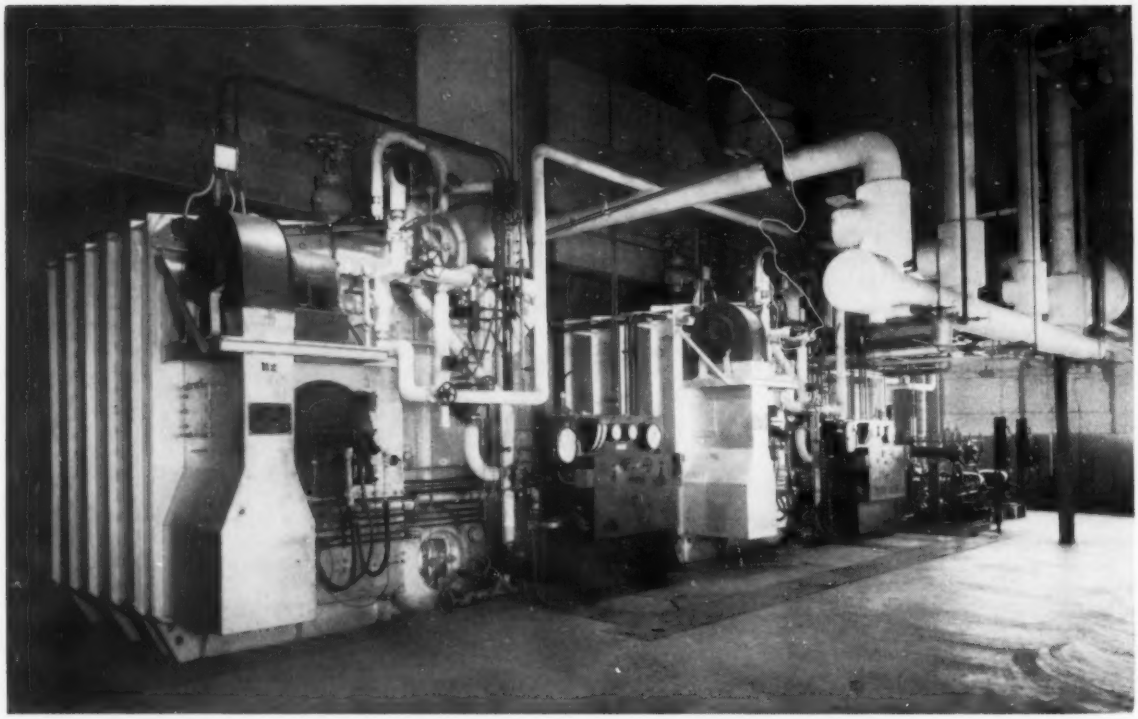
In a new plant, use either raw, zeolite-softened or demineralized water to fill the boiler for boil-out. A plant extension often uses condensate. In any event, use the purest, cleanest water available. Hardness in untreated water is of little consequence, as a large excess of softening chemicals is employed.

Add about 25% of the boil-out chemicals before starting dry-out; ordinarily you add the remainder before raising pressure for boil-out.

The object of boil-out is to saponify and remove the oil and grease that is left on the tubes from the tube-rolling operations, and to remove dust and dirt that may have accumulated on the inner surfaces of drums, tubes and headers during transit, storage and erection.

A number of chemicals have been employed successfully in boiling out boilers. Concentrations in the usual solutions vary from 2000 to 6000 ppm, equivalent to 200 to 600 lb of chemicals

(*Continued on page 222*)



CONTROL REQUIREMENTS of packaged boilers may vary over wide range. But adapting standard units cuts cost, speeds delivery

What kind of flame safeguard? How many limit controls and what type? Should the combustion controls use the positioning or metering system? These are the questions you must answer to decide . . .

'Which standard controls for my packaged boiler?'

By A W HINDENLANG, *Industrial Division, Combustion Engineering, Inc*

Why standardized controls?

► THE VERSATILITY and economy of the packaged watertube steam generator for forced-draft gas and oil firing have had a marked impact on the industrial boiler market. Widespread acceptance of this unit has caused a great deal of discussion as to the type of control and protective equipment best suited for the job.

A number of varying factors tend to complicate the selection of control equipment and safety devices that exactly suit the requirements of all potential users. Yet the practice of custom-engineering each individual control system entails the loss of all the advantages of purchasing a standardized product.

To insure keeping the benefits of standardization, packaged control systems are offered in standard, performance-proven combinations of the various components. Thus, most of the tedious detail work is eliminated and the selective process requires only an engineering evaluation of system requirements and selection of the standard control combination that best meets these needs.

Among the factors that influence the ultimate control selection are: local codes and ordinances, insurance regulations, initial and operating costs, nature of plant load, type of fuel to be burned, and degree of training of maintenance personnel. Despite apparent complexity of selection when weighing the above and other essential factors, the problem may be reduced to three basic decisions. The manufacturer

of packaged boilers aims for a control package made up of a balanced combination of these factors.

The three considerations fundamental to all control and protective systems, for oil, gas or combination oil- and gas-fired watertube packaged steam generators, are as follows: (1) Flame safeguard. Should it be automatic or semi-automatic? (2) Limit controls. How many should be used? (3) Combustion controls. Should they be positioning or metering? These three factors are discussed below in terms of comparative advantages and the limitations for overcontrol.

Flame-safeguard devices

Space does not permit treatment of the various flame-sensing devices available. One of the simplest, however, uses a lead-sulfide cell to sense both oil and gas flames. The cell reacts on a variable-resistance basis to the infrared light present in the flame and is tuned to the frequency of the infrared emission from the flame—approximately 15 cycles per second.

Most flame-protective systems are available with a programming timer arrangement by which the entire firing cycle may be made automatic.

The firing cycle is generally arranged as follows:

1. Start cycle on steam demand
2. Start forced-draft fan, purge furnace with air—fan dampers open
3. Return air and oil controls to low-fire position
4. Ignite gas pilot by high-voltage spark
5. Prove gas pilot flame
6. Ignite main burner from gas pilot
7. Shut off gas pilot
8. Prove main burner flame
9. Release control from low-fire position
10. Shut down main burner on flame failure, or limit system demand
11. Purge furnace with air—fan dampers open
12. Stop forced-draft fan

Flame-safeguard controls with the automatic recycling feature perform all the above functions without assistance of a boiler operator.

On the other hand, controls arranged for semi-automatic operation require that an operator push a button to start the cycle. The forced-draft fan is also controlled manually. The semi-automatic system incorporates two time-delay relays: one prevents ignition until the furnace has been properly purged, and a second shuts off the gas-electric ignitor after the recommended trial-for-ignition period.

A table of advantages for each of the systems follows:

Semi-automatic:

Shows lower initial cost and less maintenance

Reduces loss in boiler pressure when changing oil guns by consolidating purge cycles (forced-draft fan continues to run)

Encourages operator familiarity with equipment by requiring some manual operations

Each light-off is operator-supervised

Frees operator for maintenance duties as permitted by local regulations, although he should be in range of alarm indicating burner outage

Automatic:

Permits "infinite" load variation by recycling automatically at loads below burner turn-down range

Frees operator for maintenance duties as permitted by local regulations. He must, however, restart burner on flame or extended power failure.

Specific requirements of any proposed application, when evaluated in terms of these factors, should readily indicate whether the proposed control system should be specified as automatic or semi-automatic.

Limit controls

The second major decision in the selection of the most suitable control-system components involves the limiting controls. These may be defined as controls that limit or govern variables in the steam-generating process to insure safe operating conditions. Thus, a control that automatically stops the burner when boiler-water level drops below a safe minimum is classified as a limit control.

When considering this type of control the major decision is quantitative rather than qualitative, for it concerns the number of controls that must be applied. Apparently the interests of safety would seem to indicate that the maximum number of limit controls should be integrated into the control system.

Experience, however, shows that an excessive number of limiting controls often brings about annoying and sometimes dangerous operating conditions.

All mechanical devices including controls have faults and, therefore, possess an inherent nuisance factor. Thus the greater the number of limit controls we include in a given system, the more we multiply the possibility of nuisance shutdowns. Again, a multiplicity of limit controls increases the difficulty of locating the one faulty control and thereby increases the nuisance outage time.

Many boiler operators, faced with recurrent nuisance shutdowns caused by overlapping or superfluous limit controls, will in desperation lock the offending control devices in the "safe" position. All too frequently the entire limit system is voided for just this reason.

So the quantitative decision concerning the limit controls to be applied resolves itself into achieving a balance between maximum safety and minimum nuisance. Fortunately, the standard control systems available with packaged steam generators include all the limit-control components required by the approving bodies and, in the great majority of cases, the local ordinances. These systems exclude those devices whose functions overlap and whose contribution is minimized by their nuisance factor.

Typical standard limit-control system for an oil-fired installation contains equipment as follows: *Low-water cut-off*—stops burner when boiler-water level falls below safe operating level. *High-pressure limit switch*—stops burner when boiler-steam pressure exceeds preset value. *Low-fire start*

device—prevents light-off unless controls are in minimum-fire position. *Low-oil-temperature interlock*—stops burner when oil temperature drops below preset safe minimum for proper ignition. *Forced-draft-fan interlock*—prevents burner ignition unless fan starter is energized. *Atomizing steam interlock*—prevents oil valve opening unless sufficient steam pressure is available to properly atomize the oil (for steam atomizing burners).

Purge and ignition timing have been covered by the flame-safeguard equipment under the first major decision. To complete your decision on limit controls, you need only study the combination of controls offered in various manufacturers' standard steam-generator packages and ask these questions:

Does my proposed setup need any additional controls?

Will these additional controls have any overlapping functions?

Will the additional protection offered by any extra control device be neutralized by its nuisance factor?

Those variables not intimately connected with steam-generator functional safety should be kept separate from the steam-generator control system. For instance, water-treatment alarms and fuel-storage-tank level alarms are excellent operational guides. But they should be installed as separate systems and not tied in with burner controls.

Best guide in answering the limit-control problem is: Keep devices to minimum compatible with operational safety.

Combustion controls

We can now consider how best to maintain the proper firing rate and fuel-air ratio during the firing cycle. Matching firing rate to steam demand, handling load swings while maintaining substantially constant steam pressure, and providing optimum fuel-air ratio at all firing rates are the functions of the combustion controls—the final component in the integrated control package.

First choice relates to the means of actuating combustion controls—whether it should be electric, pneumatic or hydraulic. General practice is to use the manufacturer's standard, as he has carefully integrated the combustion controls with the flame-safeguard and limit controls. Variation from this standard usually involves additional expense, delayed shipment and extra start-up time.

Some additional factors to consider are: initial cost, installation cost, operating expense, simplified maintenance (unit replacement where possible), special operating conditions and limitations.

The primary design question involved here is whether the combustion controls should be positioning or metering.

In considering which of these types of control shall be applied to the proposed installation, remember three main points: (1) Principal basis for selection is operating economy as balanced against first cost. (2) No control can provide better combustion conditions than the controlled components permit. (3) Combustion control system, regardless of its cost and features, is only as good as its initial adjustment and continuing maintenance permit.

Positioning system consists primarily of a pressure-sensitive master controller, which simultaneously positions a forced-draft-fan-louver drive and a fuel-oil control valve. The master senses changes in load demand and sets fan and oil valve so air and oil are admitted to the furnace in the proper proportions. Correct combustion conditions throughout the load range are obtained by setting an adjustable cam on the oil-control valve to give an oil-flow curve matching the air-flow curve.

Careful adjustment of this control should furnish CO_2 test readings within one-half of one percent of best readings possible by precise manual setting. This type is usually the least expensive control. It has the additional advantage of being adjustable over as wide a range as the controlled components permit.

Metering controls have two categories—full metering and semimetering:

1. In the full-metering system, a pressure-sensitive master positions the fuel-oil control valve to adjust firing rate to suit steam demand. Rate of oil flow is measured by an orifice and measured differential pressure is used to position forced-draft-fan louvers to provide combustion air in the proper amount for optimum combustion conditions.

Combustion air flow is also measured and its measured differential acts to reposition fan-louver control to compensate combustion air flow, maintaining preset fuel-air ratio.

2. The semi-metering system differs from the full-metering system in that the burner tip is used as the oil-measuring orifice and the resulting measured pressure is not directly balanced against air flow. This system, therefore, lacks some of the advantages of the full-metering system.

For instance the majority of oil burners used in watertube packaged boilers are steam atomizers. The characteristic of this burner is: Oil flow for a given oil pressure varies as atomizing-steam pressure varies. Thus, operation of this type of control depends on ability of the differential valve to maintain the atomizing-steam pressure exactly at all points through the firing range.

One important characteristic of metering systems is that control range is limited to about 4 or 5 to 1. Thus at load ratings below 20% of maximum the metering control would be beyond its effective operating limits.

In choosing between metering and positioning combustion controls the first and simplest design criterion is the nature of the plant load. Let us assume we have a steam generator that is off the line during the two night shifts and carries normal operating load only four hours of the 8-hr day shift. Further, this unit carries an extremely low load during the other four hours of the day shift, and recycles frequently during those hours. It would be difficult to justify the cost of a metering combustion control for this unit since the controls would be effective for only one-sixth of the potential operating time.

On the other hand, if we consider a generator that is required to produce normal to peak ratings 24 hours per day with 90% availability for the year, it becomes almost essential to calculate savings that might accrue from using a metering system. Unless actual cost data from similar installations are available, efficiency increase must be assumed. Representatives of the control manufacturer should be consulted before making this assumption.

Other considerations that require more complex treatment are operating flexibility, maintenance required, availability of service engineers, functional safety. These must all be examined in the light of the particular make of control that is being considered.

Combustion Gas Data

► THIS TABLE puts in one place all important numerical data that are needed for most combustion computations. This information speeds up such calculations as excess air, volumes, weights, heat absorption and release.

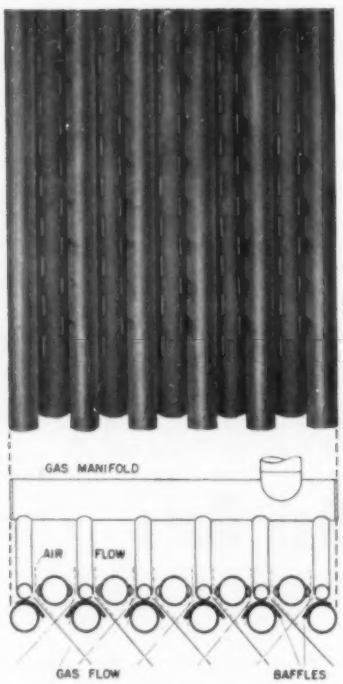
ROBERT F CLOTHIER
Alabama Polytechnic Institute
Auburn, Alabama

Gas	Specific gravity (Air = 1)	Density, lb/cu ft*	Specific volume, lb/cu ft*	Molecular weight	Specific heat at one atmosphere, Btu/lb F 4					
					32 F	212 F	400 F	600 F	800 F	1000 F
Air	1.000	0.0767	13.05	28.96	0.240	0.241	0.245	0.250	0.247	0.263
Carbon monoxide	0.966	0.0740	13.52	28.01	0.248	0.250	0.253	0.259	0.265	0.272
Carbon dioxide	1.518	0.1162	8.61	44.01	0.195	0.219	0.239	0.256	0.269	0.281
Nitrogen	0.972	0.0745	13.42	28.02	0.248	0.249	0.251	0.256	0.262	0.269
Oxygen	1.104	0.0845	11.83	32.00	0.218	0.222	0.230	0.239	0.246	0.252
Sulfur dioxide	2.264	0.1734	5.76	64.06	0.145	0.159	0.171	0.181	0.189	0.195
Water vapor	0.622	0.0476	21.01	18.02	0.444	0.451	0.465	0.478	0.497	0.516

*Based on 60 F at one atmosphere pressure

© POWER

Modern... Outdoors...



Section of Riley Intertube Burners shows tube arrangement and baffles. Drawing illustrates how gas pipes are protected by water tubes while baffles welded to front tubes assure positive and uniform mixing of gas and air.

View of lower boiler drum open at ends showing Riley submerged type heat exchanger.

Two new Riley pressurized furnace steam generating units, installed in a Texas chemical plant are operating at high efficiency. The design is completely modern in concept: induced draft fans have been eliminated, new Riley Intertube Burners for firing natural gas are used for the first time, and special considerations have also been made to insure low cost, clean steam from feedwater high in solids and silica content.

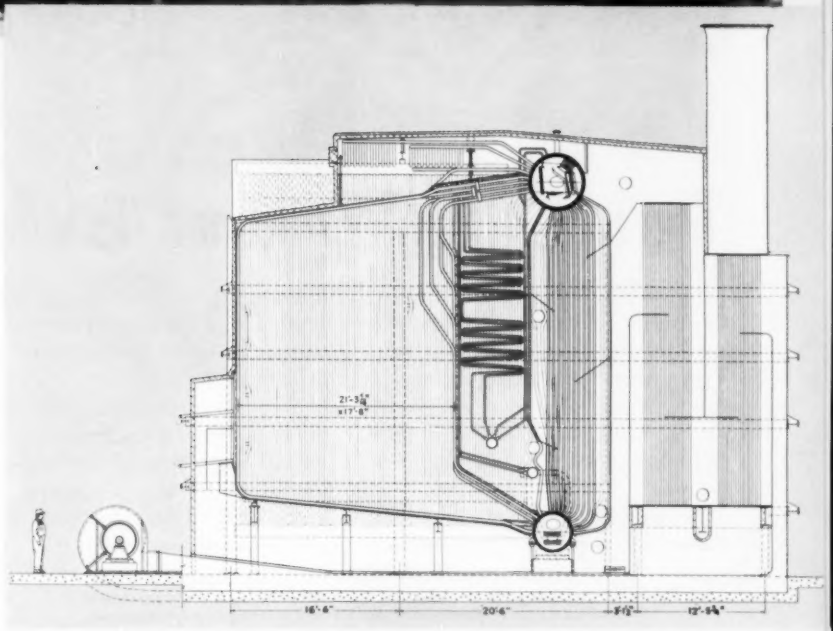
A Few of the Outstanding and Exclusive Riley Design Features of these Twin Riley 200,000 pounds per hour Pressurized Furnace Units

- Insulation over an all-welded inner casing is "plasticized" to resist weathering.
- All waterwall tubes are welded to stub tube ends in headers, not rolled.
- Compact design of hot and cold air ducts permits low cost installation of forced draft fans.
- New Riley Intertube Burners for firing natural gas make possible low excess air and also do away with exposed burner refractory, resulting in complete elimination of furnace refractory maintenance.
- "Wall of Flame" characteristic from this new Riley burner provides unusual uniformity of heat distribution across furnace with uniform heat absorption across superheater.
- The effectiveness of the Riley Condenser Type Steam Purifier in main steam drum produces the unusual steam purity of only 0.33 ppm solids and 0.010 ppm silica in spite of boiler water concentration as high as 4000 ppm solids and 94 ppm silica.
- A submerged type Riley heat exchanger in lower drum provides constant steam temperature over a wide load range.

When steam generating equipment must be "tailored" to meet specific requirements, you too will find Riley engineers thoroughly qualified to fill your needs. A survey of your power plant requirements by a consulting engineer will possibly show you ways of making surprisingly large savings in your power costs.

Pressurized!

This completely outdoor plant has Riley gas burners and f-d fans at front wall of boiler. Control room, center, is the only enclosed part of plant. Operators have clear view of all auxiliaries in 40′ wide aisle between boilers, also of turbines at left of control room. Note absence of structural steel.



ENGINEERING DATA

Maximum Continuous Capacity—each unit—200,000 lbs./hr.
Design Pressure—1075 psig
Operating Pressure—1000 psig
Superheater Temperature—850F
Furnace Volume—10,000 cu. ft.
Furnace Height—30′-6″
Furnace Width—17′-8″
Furnace Depth—21′-3/16″
Heat Release in Furnace Btu/cu. ft./hr.-29,900
Riley Cross Flow Air Preheater—38,000 sq. ft. surface
Eight Riley Intertube Burners
Efficiency—each unit—83.1%

RILEY Stoker Corporation

WORCESTER, MASSACHUSETTS

Boston New York Philadelphia Buffalo Washington Pittsburgh Cleveland Detroit Chicago Cincinnati Charlotte New Orleans
Atlanta St. Louis Kansas City St. Paul Tulsa Houston Denver Salt Lake City Los Angeles San Francisco Portland Seattle

COMPLETE STEAM GENERATING UNITS

AND FUEL BURNING EQUIPMENT FOR PUBLIC UTILITIES, INDUSTRIAL POWER AND HEATING PLANTS

The leader has lengthened its lead!

From the day it was announced, the Marsh Mastergauge took the lead in the pressure gauge field. You are probably well aware of this . . . but do you realize that we have constantly given it plus qualities to still further *lengthen* its lead?

Look at the recent developments presented opposite. Unquestionably these are the three greatest strides in gauge development since the creation of the Marsh "Recalibrator."

Yes, the three basic gauge components have been brought to a remarkable stage of perfection in the Mastergauge. Certainly, for every critical service there is no gauge to compare with it!

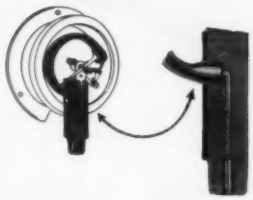
Mastergauge is standard bearer for the world's broadest line of gauges and dial thermometers, each the best of their kind in the applications for which they are recommended. Ask for data covering your specific needs.

MARSH INSTRUMENT CO. *Sales Affiliate of Jas. P. Marsh Corporation*

Dept. F, Skokie, Ill.

ONLY MARSH HAS THE "RECALIBRATOR"

MARSH THE STANDARD OF ACCURACY

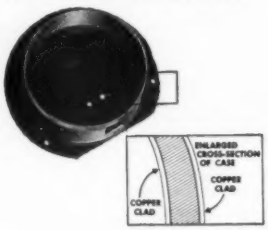


1—A better tube construction—

The Mastergauge always had the most effective joining of the bourdon tube to the socket . . . but . . . one-piece *construction is always better!* Welding these dissimilar parts posed a tough problem . . . but we finally solved it by a new process—the "Conoweld" process—exclusively ours. The photo of an actual section shows the perfect fusion. Socket, tube—even the end-piece—are fused into one leak-tight unit.

2—A better movement—

To convert the action of the bourdon tube into accurate pressure indication, the gauge movement must be rugged, practically frictionless, highly resistant to corrosion. A self-lubricating effect is achieved in the Mastergauge movement by using alternate stainless steel and monel—gears stainless, bushings "K" monel, and so on. A distinguishing feature is the "coined" sector gear. Note broad face of gear which results from this coined extrusion.



3—A better case—

Another development that has increased Mastergauge leadership is the new copper-clad, wrought steel case. The case has the strength of steel and the resistance to corrosion of copper. It is four times as strong as a cast iron case and one-third lighter. Final finish is a handsome corrosion resistant black enamel. Every case is fitted with Marsh safety blow-out plug—a typical advancement.

By W A BARROWS
Barrows Porcelain Enamel Company

Porcelain enamel fights corrosion...

on your boiler tubes, pump impellers, coal screws, heat exchangers, thermocouple shields, smokestacks, breechings, induced-draft fans—many other items

HEAT-DEFLECTOR CONE, ceramic coated, for petroleum processing furnace. Pieces shown give idea of sizes that can be coated. Cone here was done in two sections

► POWER ENGINEERS are turning to porcelain enamel for licking many tough temperature-corrosion problems. Two major groups of porcelain coatings, based on temperature ranges, are used in industry: One goes up to 1400 F; the other, known as high-temperature ceramics, reaches 2000 F. Intensive research in this last-named group, which is fairly new, has been sparked by jet-engine needs.

Temperatures desired in this field have reached or exceeded the limits of many newer alloys of metals. And jet-engine problems have shown some surprising advantages of porcelain.

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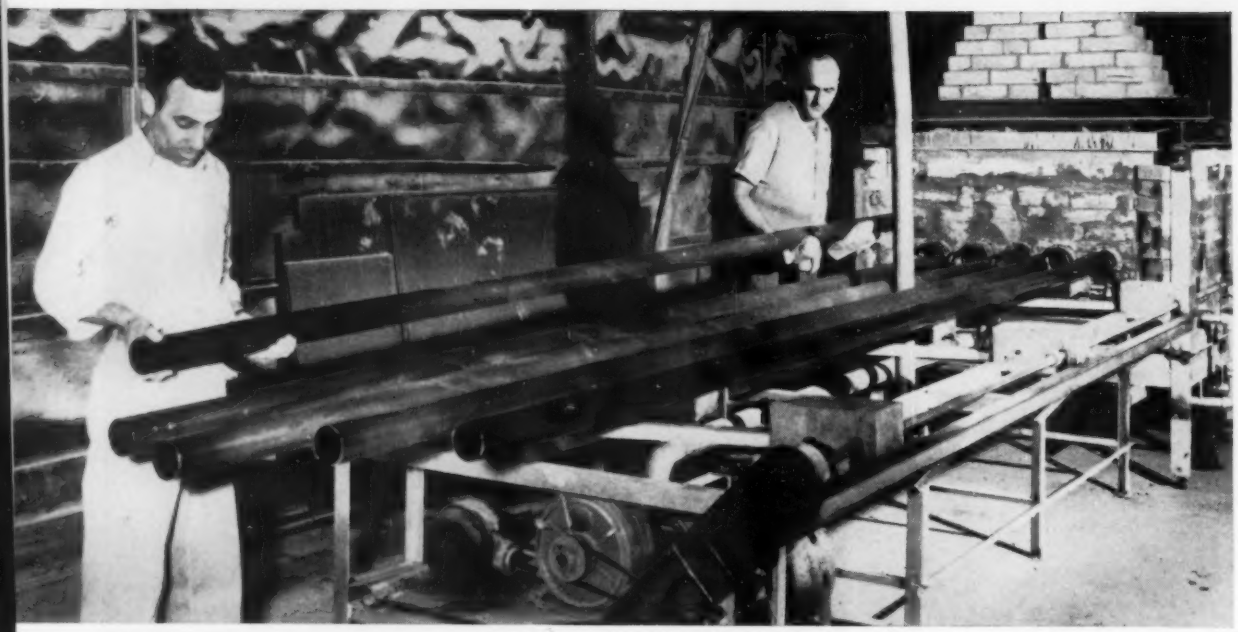
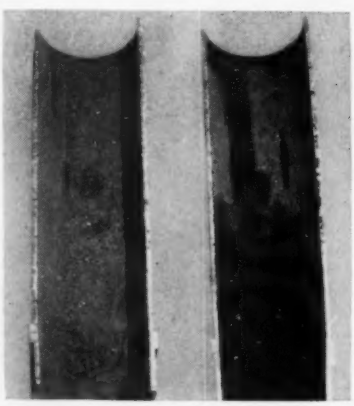
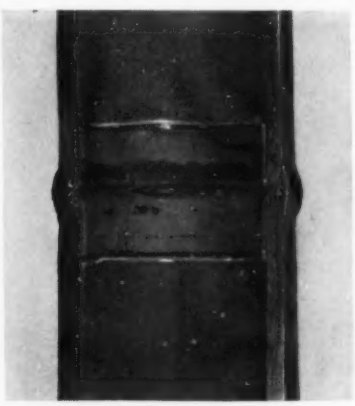


PIPING for fighting corrosion and temperature is porcelain-coated in this special furnace. Cost is higher than for uncoated piping but service life more than pays for job. Each problem is studied and coating engineered to meet conditions

HOUSING of deepwell pump is coated on inside to cut down friction, corrosion



FLYASH is easily rubbed off vitralloy-coated tube (dark surface) with finger



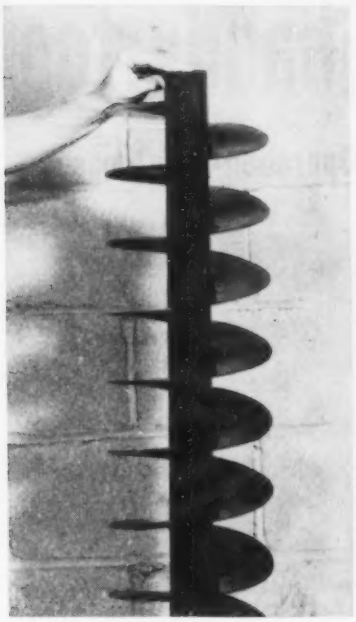
COATED INSERT joins enameled piping in field, welding-torch heat fuses to pipe

High temperatures and corrosive fluids might be licked in your plant by applying the coatings explained on these pages

Here are characteristics of porcelain enamel: (1) high-temperature and corrosion resistance (2) smooth surface (3) electrical resistance and insulation value (4) good emissivity factors (5) good sanitary characteristics (6) extreme hardness (7) good thermal shock properties (8) high-reflectance value (9) mechanical shock properties and (10) variety of colors. Some of these properties can be varied.

Pipe problem. In 18 months, 2,000,000 lb of black steel pipe were saved in an aluminum fluxing operation. Pipe carried chlorine to molten aluminum where surface temperature often reached 2000 F. Pipes were partly immersed in molten metal. Uncoated pipes lasted about 8 to 10 minutes, while coated pipes averaged 120 minutes. Coated pipe cost about four times as much, but life increased about 13 times for a very substantial saving.

Conveyor screw for moving wet, fast-setting gypsum slurry



CONVEYOR SCREW is enamel-coated to cut down corrosion and to reduce friction

THERMOCOUPLE protective tubes last four times as long since coating with porcelain. Here author Barrows inspects coating that took 1½ years to lick temperature problem

from mixing hoppers to main gypsum pumps gave trouble. Solution was to coat with slick, glassy porcelain enamel. Before coating, conveyor became clogged and jammed. Then gypsum had to be knocked loose with sledge hammers.

At first, we believed porcelain couldn't be applied because of variation in base-metal thickness. Because of firing method used for porcelain, problem was caused by different heat-transmission factors of metal with varying thicknesses.

Carefully controlled series of firings solved this problem. Base metal of plain iron was substituted for stainless steel. In common use, these 4-ft-long screws prevent jamming the system. And coating resists abrasive action of gypsum. Rust is also prevented. Prime savings here are increased production and lower maintenance cost.

Air heater outages in large power boilers are now cut down with glass-coated steel tubing. Tests over three years show that expensive preheater-tube replacement is lowered. Pipe up to 3-in. outside diameter has been coated in long lengths and acid resistance had to be combined with strength. Problem of caked layers of flyash, carbon, and scale, which cause efficiency to drop, is reduced but not eliminated. Smooth glass surface will inhibit caking and make cleaning easier.

Power-plant operators are eying not only normal savings through longer tube life, but also hidden losses and costs of tube outages. We hope to cut steel-tube corrosion failures way down.

Flue gas handled at lower temperatures should bring added savings. Such temperatures bring a higher concentration of sulfuric acid which has prevented their use until now. Boiler efficiency goes up as stack temperatures come down. But breeching and draft-induced fan, nozzles and stack should be coated with porcelain enamel also to take advantage of these lower temperatures. Several porcelain-enamel smokestacks are now under test. Results should be interesting.

Catalyst contamination is a problem in many industries. Since rare metals like platinum are often used, cost can be as much as $100,000 per charge or more. And slight contamination makes catalyst charge unusable. Linings of chambers holding catalyst and material in process are now coated with porcelain enamel. This prevents contamination by eliminating contact between nickel alloys and catalyst. Here the basic inorganic nature of porcelain enamel is used to prevent any chemical reaction.

Thermocouple protective tubes used in making aluminum are coated to extend life of both tubes and thermocouples. As a result, life of coated tubes has increased to 400%. Cost of replacing thermocouples is also reduced.

Tube is made of cast iron from bottom to hot-metal line. Above, tube is plain iron. Cast iron provides base for porcelain-enamel coating, which is an entirely new development. Project lasted a year and a half, involving resistant materials and problems of building them into glass having right characteristics.

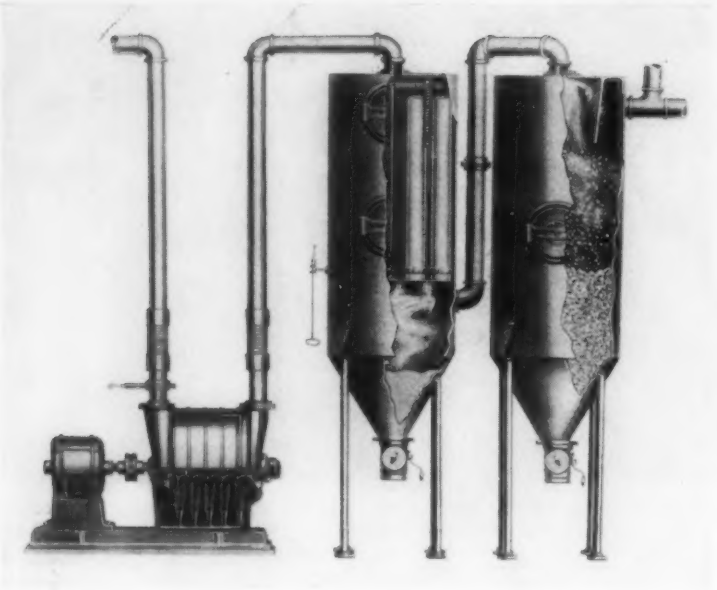
Deepwell-pump housing was coated to reduce friction to a minimum. Covering area where water is forced upward from extreme depths, coating was specified to provide fastest possible flow in area of greatest friction. Coating also protects cast-iron metal housing against rust and deterioration. Each housing of multistage pump is coated. This includes circular walls and taper fins. Same idea applies to nozzle orifices of jet-type pumps to reduce friction, increase efficiency, and withstand scouring action of high-velocity liquids.

Petroleum processing furnace costs were lowered and expected life increased. In this furnace—a standard radiation-convection type—ceramic-coated heat-deflector cone is subject to 1800 to 2000 F. Flame burner is right under this cone and flame impinges directly on tip. Hung tip-down from top of

(*Continued on page* 220)

OPERATORS' NOTEBOOK 76

Vacuum is a handy tool



How system works

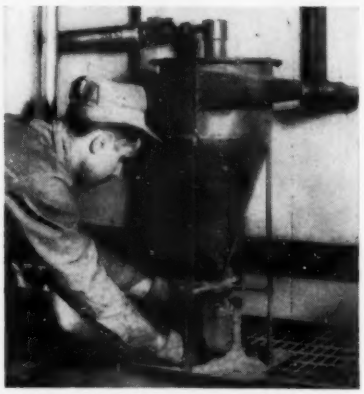
Dust-laden air enters the primary separator near top and whirls around the baffle. Heavier material falls into hopper at bottom. About 95% of material is trapped here.

Lighter and finer particles flow up through top and down into side of secondary separator. Here the heavier particles reach bottom by centrifugal action and gravity. Finer airborne particles rise to inverted dust bags near top. Upward air stream, now moving at greatly reduced velocity, passes through fabric, trapping dust on inside of bags.

Cleaned air is now drawn into exhauster's inlet, through five stages of impellers where it's compressed so it can be discharged into outside atmosphere. Exhauster housing is a series of cast-iron sections held together with tie rods on outside. Impellers are aluminum alloy, keyed to steel shaft. With no internal wearing parts and only filtered air entering exhauster, there's little maintenance. Exhauster housing need seldom be opened; ball bearings can be removed from ends without disturbing housing.

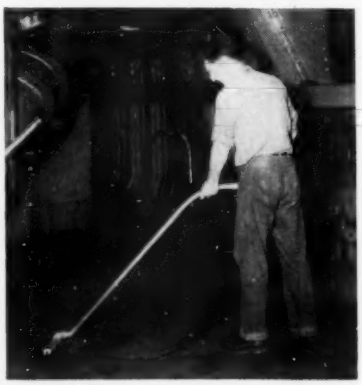
Piping-system details are important for air must flow into main lines at an angle from the branches. Otherwise, system becomes plugged, loses capacity.

Operation-maintenance



FLYASH SAMPLE is collected in a jar from flue gas by plugging cyclone into vacuum inlet, snapping bottle into place

Cleaning tool



COAL DUST from floor and coal conveyor is cleaned with 15-in.-wide floor tool

What you should know

A permanent vacuum-cleaning system is a good maintenance tool. What we mean is shown at Elrama Station of Duquesne Light Co where Chief Engr Leo Tattersall and his maintenance crew put their imaginations to work.

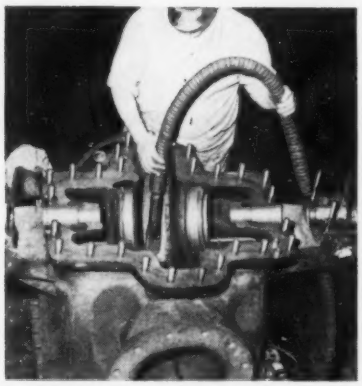
Vacuum in this plant cleans pulverizers and other pieces of equipment. When a boiler is shut down for inspection or repairs, passes are thoroughly vacuum cleaned. Some more of its tasks are collecting flyash for combustion analysis and doing many maintenance jobs, *not shown in photos.*

Maintenance tips. To keep system in order: (1) Make sure gaskets seat properly in inlet cap-covers. With many wall inlets, leaky cap-gaskets cut down efficiency. (2) Check bags in secondary separator for holes. Excessive dust on bag's outside is either a sign of worn bag or improper shaking. Holes in bag allow dust to get into exhauster, which cuts down efficiency. (3) Check oil level in bottles at exhauster bearings. If there are signs of bearing wear, inspect by removing plates at bearing ends.

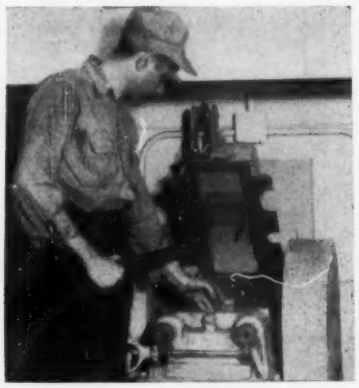
(4) Check tools, especially those with bristles or fiber inserts. Replace when worn so metal part of tool does not wear. (5) For safety, hoses have ground wire from tool end to wall outlets to prevent the buildup of static charges. Check to find out if hose is staticproof. Do this either with a megger or a simple flashlight circuit.

for maintenance, cleaning

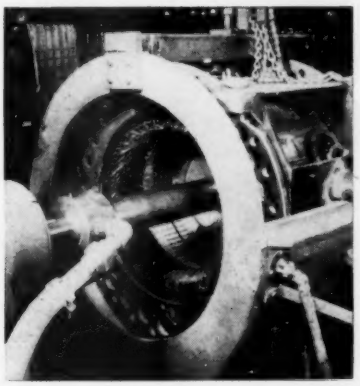
By STEVE ELONKA
Associate Editor



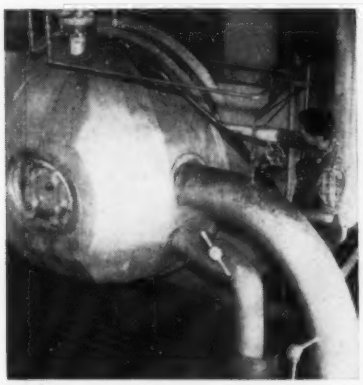
REMOVE foreign particles before assembling overhauled machinery. Opened equipment should always be vacuumed



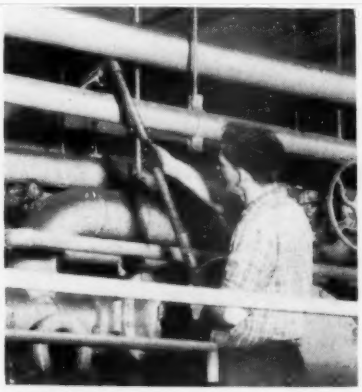
LABORATORY coal-sample crusher must be clean or sampling is inaccurate. A ¾-in.-diameter tip gets to all crevices



CHIPS are continuously drawn away from this motor boring job. Bar is hollow, has holes leading to vacuum connection



BOILER DRUMS on coal floor get dirty, need 8-in. round brush on cleaner's end



OVERHEAD lines take special pipe brush like this one to loosen dust, speed job

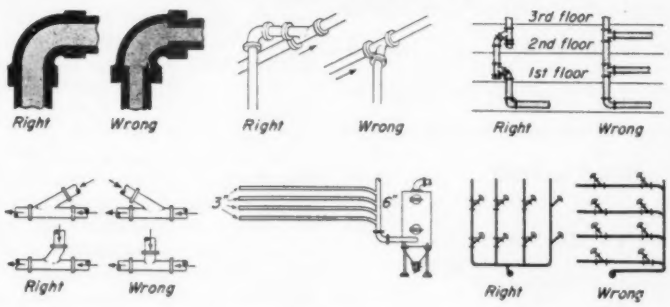
VACUUM clothing. Blowing injures eyes and blows sharp particles into your skin

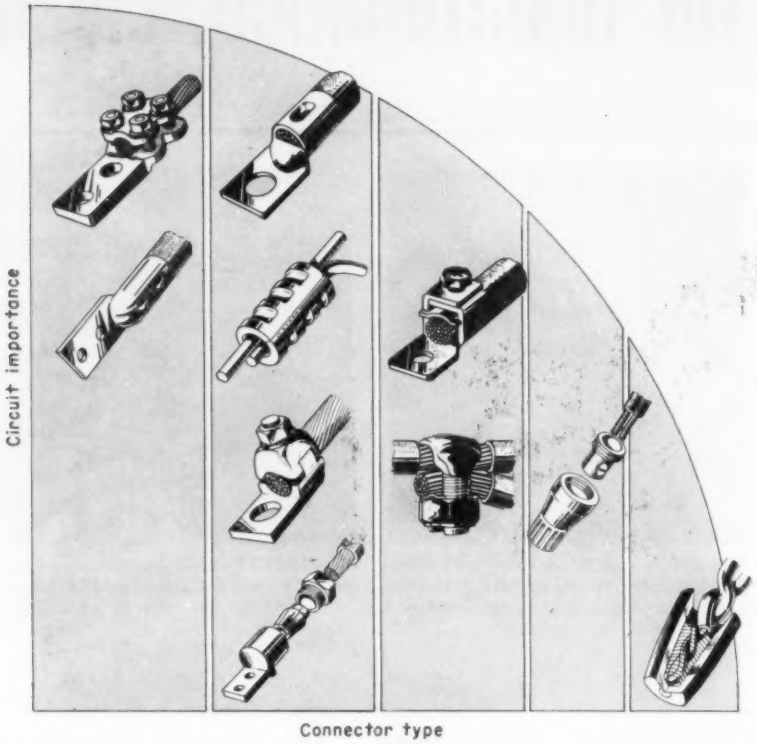
Putting leads on each end of hose will check for breaks in conductive wire inside. Hoses last longer if hung up when not in use. If rubber, keep away from oil and other harmful chemicals.

Exhausters are built for vacuums from 2 to 11½ in. of mercury. Fitting sizes to use: (1) 1½ in. for general housekeeping (2) 2 in. for fairly heavy deposits and (3) 3 in. for heaviest deposits. Follow maker's instructions.

Photos, courtesy, U.S. Hoffman Machinery Corp

FOLLOW RIGHT PIPING TIPS





SELECT CONNECTORS on basis of circuit importance. Double-indent and 4-bolt clamp types are best suited for critical sections of plant electrical distribution system

Whether you're joining copper or aluminum, study...

Circuit location: key to selecting

As a follow-up on last month's article, here are the factors that pin down connector selection for all parts of the industrial plant's electrical-distribution system. How-to angle of applying aluminum connectors is covered to boot

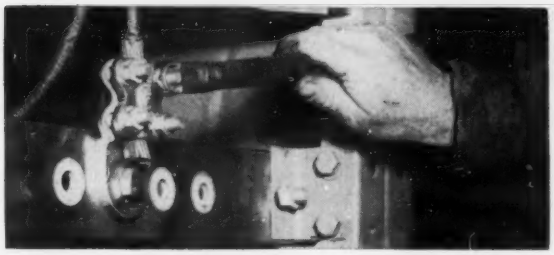
By **MORRIS BRENNER**
Associate Technical Service Engineer
Burndy Engineering Company

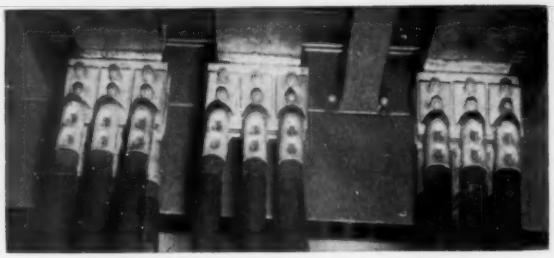
► TODAY'S top-quality electrical connectors will match, with room to spare, the two basic requirements for any conductor. First, connector resistance will be the same or lower than an equivalent length of the conductors being joined. Second, temperature rise of joint will be less than temperature rise of conductors. Both factors are closely linked since they depend largely on joint resistance.

Relative conductivity of joint, compared to the conductor, should be at least 100%. This means the voltage drop across connector is less than voltage drop across an equivalent length of conductor. From the temperature angle, the connector should not introduce more heat into the circuit than would a conductor of equivalent length.

Lab tests. Manufacturers use two tests to evaluate both factors: One, a relative conductivity test, measures joint resistance with a Kelvin bridge. This reading is then compared to resistance of an equivalent length of cable. The other test is really a heat run. Here the joint is made to carry an ampere load greater than it is expected to carry in field service.

Thermocouples are placed along both the conductor-and-connector and temperature readings taken. Results of a typical heat test are shown on facing page. Here a 4/0 cable was loaded beyond twice its NEC rating. Note from curves that connector is consistently cooler than cable, even under 100% overload. It's thus safe to assume such a connector will not overheat even under





Answer these questions before selecting connector types

BOLTED

1. Are there enough bolts of proper size?
2. Are bolts set close to conductor?
3. Is connector long enough to grip conductor properly?
4. Is connector material suited for use with the particular conductor?
5. Is connector easy to tape?

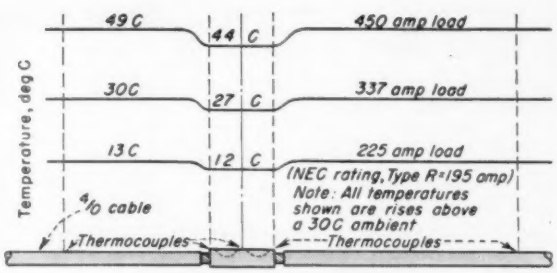
COMPRESSION

1. Does conductor fit snug in connector?
2. Will die deform the conductor without overcompressing the strands?
3. Is installation tool easy to work with?
4. Is there enough tolerance built into the crimp to allow for variation in installation pressure?

Overload test proves connector runs cool

A tight, low-resistance connection is a cool one that won't overheat. Connections properly made with modern connectors run cooler than the conductor itself. This point is brought out in sketch of test setup, *right*. Here the joint is made to carry an ampere load greater than it is expected to carry in field service.

Thermocouples are placed along both conductor and connector, and temperature readings taken. Results for such a heat test on a 4/0 cable are shown in sketch. Note cable was loaded beyond twice its NEC rating. Curves indicate connector was consistently cooler than cable even under 100% overload. It is thus safe to assume this connector won't overheat even under severe service.



the right electrical connectors

the most severe industrial service.

Voltage range. Through 600 v, standard connector designs available today are suited for insulated or bare conductors. Standard compression-type connectors are recommended for voltages up to 5 kv with insulated conductors. Above 5 kv, corona generally makes the tapered-end compression connector the wisest choice. Trend is toward use of tapered-end compression connectors, for all primary voltages.

Mechanical (bolted) type connectors can be used for all primary voltages provided the bus is uninsulated. But where conductors are insulated, use of the mechanical connector is often limited by difficulty in making a joint with all voids and air pockets filled so it will not break down in service.

Selection. The decision on what connector to use hinges directly on the reliability required in the portion of the plant distribution where the connector is to be installed. The chart on facing page gives an approximate index of reliability for different connector designs. Big factors in final selection are class of duty, location, environment and availability of crimping tools.

Connections made in the plant generator leads, or in the feeders at primary substation if power is purchased, are the key points in the entire distribution system. A connector failure here may knock out the complete plant. In contrast, if a connector overheats on the leads of a single plant motor, only that motor and its connected process are lost.

Study the application chart on p 119 and note how connector-force distribution ties in with proper selection. *How a connector distributes force to and around a conductor influences its ability to stand up under field operating conditions.* Lighter connector designs may be used in sections of distribution system where conditions are less severe.

CONNECTING ALUMINUM

Aluminum conductors are different from copper in four ways, each affecting connector selection: (1) Aluminum is softer than copper and cold-flows at lower pressures. (2) Galvanic corrosion may occur with aluminum since it is higher in the electromotive series than copper. (3) Aluminum tends to form a surface oxide film of high contact resistance. (4) Aluminum has a coeffi-

ALUMINUM CONDUCTORS

. . . 5 tips on installation

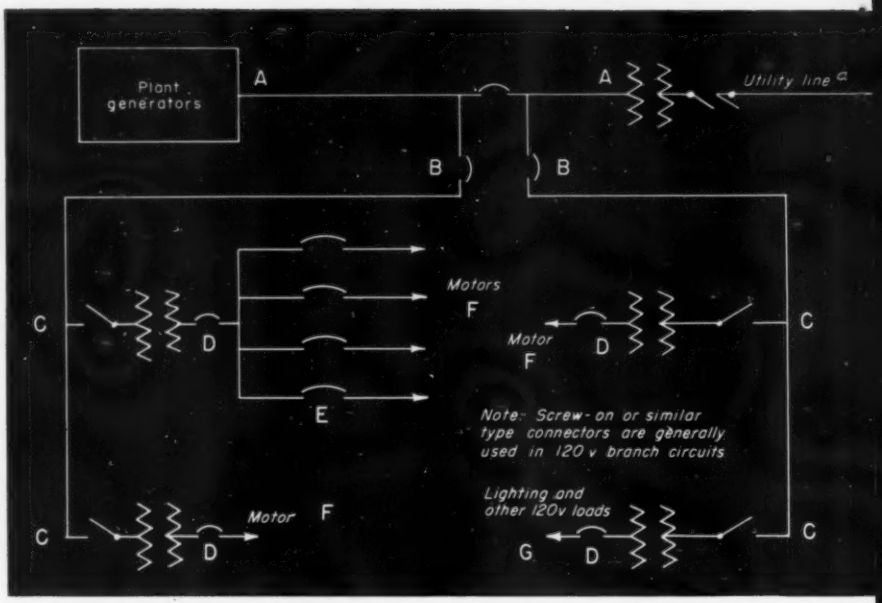
1. Use care in stripping insulation to avoid nicked strands. Nicked aluminum strands break easily

2. Always use a joint compound. Its oxide-penetrating corrosion-inhibiting and sealing properties help insure continued high conductivity under corrosive and heat-cycling conditions. Wipe excess off insulation

3. In connecting copper to aluminum, place aluminum conductor above copper. This prevents soluble copper salts forming electrolytic path that may ultimately destroy aluminum conductor

4. When joining insulated conductors, trim insulation close to connector to reduce weathering of joint

5. Where possible, tape or otherwise insulate joints, whether aluminum-to-aluminum or aluminum-to-copper. To seal out moisture, use mastic, vinyl or rubber tape. Don't use friction tape directly on connector; it retains moisture that leads in time to severe corrosion



Check connector needs here...

Then use table to select type →

cient of thermal expansion greater than copper which must be compensated for.

Cold flow is a gradual shifting of metal from high- to low-pressure areas. So in clamp or compression type connectors, contact areas must be large enough to prevent this migration by reducing contact pressures. Where contact area is too small, contact pressures developed are too high. This, in turn, causes cold flow with resulting relaxation leading to a hot connection.

Aluminum oxide has a high electrical resistance. It must be removed or penetrated before you get a satisfactory electrical joint. This film can be quickly removed by coating the current carrying surfaces with an aluminum-joint compound and then cleaning with wire brush or emery cloth *after the compound is in place*. When you use a compression connector factory-filled with compound, the wiping action of indenting die removes this oxide film without additional cleaning if conductor is reasonably clean.

Compound serves to seal the joint against oxidation and corrosion by preventing air and moisture from reaching contact surfaces. Manufacturer places metal particles, such as zinc, in a joint compound for two good reasons: (1) to help break down the oxide film (2) to act as current-carrying "bridges," filling areas where the oxide film has been broken on the aluminum contact surface.

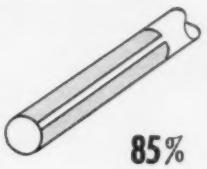
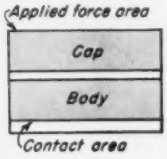
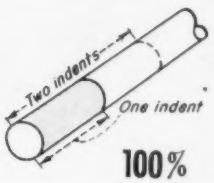
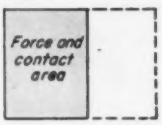
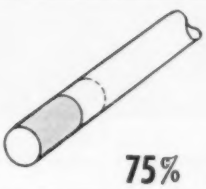
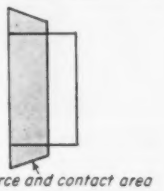
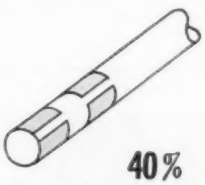
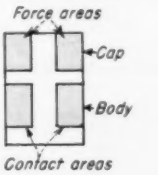
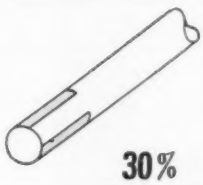
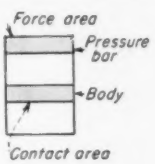
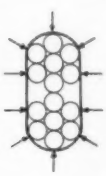
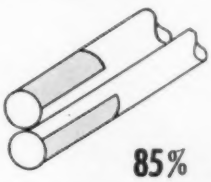
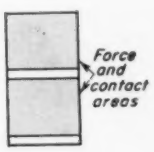
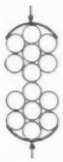
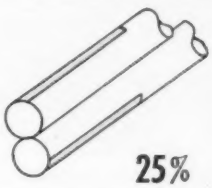
Thermal expansion of aluminum is greater than of copper. Actually, the linear coefficient of thermal expansion for aluminum is about 50% greater than for copper. This presents no problem under temperature changes met in industrial electrical distribution systems with properly designed connections. Aluminum hardware maintains adequate joint compression under a wide temperature range. Example: Temperature change of 100 F in a typical aluminum-to-copper joint changes the stress in a ½-in. aluminum alloy bolt from about 28,000 psi to not less than 25,000 psi. This latter pressure is still more than enough to maintain an adequate connection. This fact has been proven in heat-cycle tests under severe overload conditions.

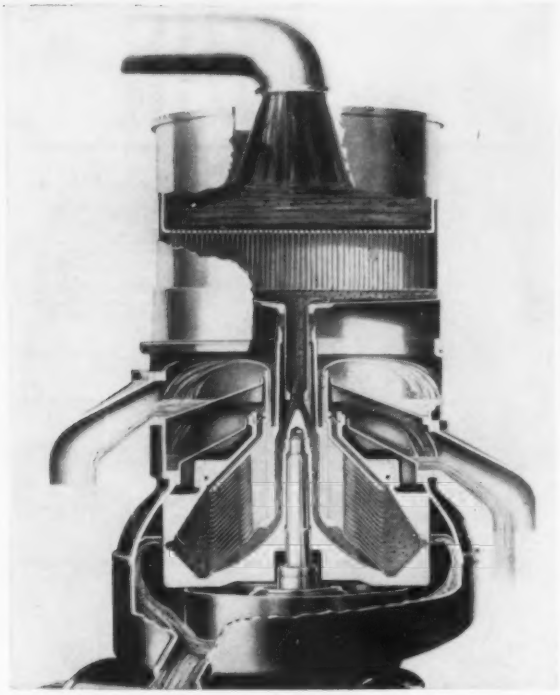
Galvanic corrosion results from galvanic-current flow between dissimilar metals. This in turn depends on the presence of moisture (electrolyte), relative cathodic-anodic areas, geometrical relationship between the dissimilar metal surfaces, etc.

Use of the joint compound, as mentioned above, holds back galvanic corrosion since it keeps moisture away from contact surfaces. Large anodic (aluminum) areas and masses also check galvanic corrosion. In years past, it was considered poor practice to use a copper conductor directly in an aluminum connector. But today aluminum connectors are used directly on copper without need for bushings or plating. These designs have a large anode (aluminum) compared to the cathode (copper). Using such connectors with a suitable joint compound reduces galvanic currents to a minor value. And any corrosion that does result occurs only in the relatively large mass of aluminum.

Copper bushings or bimetal liners are sometimes used for aluminum to copper joints. Here the liner is soldered to the connector's contact surface. But since the solder used to sweat the bushing into place is usually anodic or sacrificial with respect to copper, the solder is eaten away by galvanic attack under severe operating conditions. Corrosion products formed between bushing and casting tend to lift the bushing off, contributing further to joint failure. When bushings are not soldered in, dissimilar metals at edges will corrode.

The 7 most widely used connectors in industrial plants, and how each works

Recommended conductor range	Maximum environment	Suggested plant location (see sketch, facing page)	Type connector	Force system	How connector makes contact (percentages shown relate approximate force and contact area to the total possible area)
No. 2 stranded: 2000 Mcm	Severe outdoors or indoors	A, B or C	4-BOLT-CLAMP		 
No. 14 stranded: 2000 Mcm	Severe outdoors or indoors	A, B, C, D, E, F or G (double-indent suggested for extremely severe locations)	INDENT		 
No. 6 stranded: 2000 Mcm	Severe outdoors or indoors	B, C or D	COMPRESSION CONE		 
No. 8 stranded: 1000 Mcm	Moderate outdoors or indoors	C, D, E or F	EYE-and-CAP		 
No. 14 stranded: 500 Mcm	Moderate indoors	D, E or F	SCREW-and-PRESSURE BAR		 
No. 8 stranded: 4/0 stranded	Severe outdoors or indoors	B, C or G	CRIMP TYPE		 
No. 14 stranded: 1000 Mcm	Moderate outdoors or indoors	B, C or G	SPLIT-BOLT		



CENTRIFUGE, continuous nozzle type, makes three separations simultaneously. Purified oil discharges through upper spout

ASME Oil & Gas Power panel:

Is purification the diesel

'. . . the major problem facing the diesel industry is that of burning lower-grade fuels, and the purpose of this session is to define the problems of diesel-fuel-oil purification that arise after completion of the normal refining process'

► THE REMARK ABOVE, taken from the minutes of a recent meeting of the ASME Oil & Gas Power Division's General Technical Committee, points up both an opportunity and a pitfall to diesel-plant operators. The opportunity—to realize fuel-cost savings that can provide the margin of profit necessary to economically justify their operation, or show an increased rate of return. The pitfall—poor maintenance and operating methods that can result in expenditures that completely overshadow fuel-cost savings. By operating methods we are referring specifically to purification techniques for lower-grade fuel oils. Summarized here are highlights of this meeting as they relate to heavy-fuel purification.

SLAG or ash deposit on face of exhaust valve from heavy-fuel-burning diesel engine. Note how slag runs toward stem

Operating experience proves:

Heavy fuel for diesels

By **ROBERT DODD,** *Chief Engineer*
Clay Electric Co-op, Keystone Heights, Fla.

'It can now be definitely stated that, with care of the engines, savings can far outrun the increase of maintenance and operating costs necessary to keep the engines in condition to tolerate the burning of bunker-C fuel oil'

► WE BASE the above statement upon 11 engine-years of operation with bunker-C fuel at Clay Electric Co-op, from February 1951 to March 1, 1954. During this period, 2,875,655 gallons of bunker C have been burned without blending-in light fuel. Average difference in price between regular

operator's answer to heavy-fuel pitfalls?

Purification methods. Filtering distillate fuels, such as the No. 1, 2 and 3 grades, isn't much of a problem. Present-day cartridge-type filters (cotton, bronze or paper) do a good job in removing the abrasive dirt and the relatively small quantities of insoluble gums.

On the other hand, purifiying low-grade fuels is much more complicated. The conditioning or purification program starts at the point of storage. Storage tanks should allow for some settling or heating. Heating is necessary to attain a viscosity that permits fuel to flow and be filtered. Sometimes centrifuging is necessary to remove water and sediment. Remember to follow the centrifuge with a filter for removing very fine foreign particles left in the fuel. Some heavy-fuel setups operate best with a fine (100-150 mesh) strainer rather than an absorbent or bag-type filter. Also, filter can be damaged if fuel temperature is too high.

Because of unstable components in many of these fuels that precipitate with time and temperature cycling, it's a good idea to purify right at the engine and at approximately the required flow rate.

Additives. Can the instability problem be overcome? This question has received much recent study by the railroads and oil refineries. They have come up with a very optimistic picture: Treatments are inexpensive—one to two cents per barrel. Additive can be mixed in at refinery. Benefits are (1) increased storage stability—wards off sludge formation (2) prevention of corrosion on iron surfaces exposed to oil (3) minimized injector sticking (4) increased availability of fuel's Btu content (5) greater flexibility of fuel selection.

Cost factors. When considering heavier fuels we hope to take advantage of their usually lower price. Fuel savings must not only amortize additional equipment but must also pay for increased maintenance and still show a lower production cost. Prices vary from one area to another, but delivered prices quoted for one diesel plant are typical: No. 2, $.1183 per gallon; No. 5, $.0868 per gallon; No. 6, $.0582 per gallon. Note that the spread in price between No. 2 and No. 5 oil is about 3 1/6c per gallon and that the difference between No. 2 and No. 6 is over 6c per gallon. When competing with highly efficient steam plants, economic survival can hinge on the successful use of the residual fuels.

Panel members included: R W Seniff, B&O Railroad; J A Worthington, Koppers Co; F L Townsend, W W Nugent & Co; L D Thompson, Fairbanks, Morse & Co; T Moore, Municipal Utility, Lowell, Mich.; D M Landis, DeLaval Separator Co; F L Nelson, Socony-Vacuum Labs; C F Pervier, Baldwin-Lima-Hamilton Corp; J W Ryznar, National Aluminate Corp.

NOTE: Heavy, residual, lower-grade and bunker fuels are usually synonymous terms that describe the residual products of refining. They contain more impurities—and sell for a fraction of the price of distillate fuels

is saving $$ at Clay Electric Co-op

distillate fuel and the bunker-C fuel oil is $0.05213. Savings that can be credited to bunker C amount to $149,834.

Dollars picture. Against these savings—equivalent to the price of an engine—can be charged 16 exhaust valves, six fuel-pump plungers, two sets of piston rings, and the labor required to perform four overhauls, for a total cost of $4316. Engine parts were lost because of ignorance of conditions required for using bunker C. Now that we've ironed out the problems, maintenance costs of the engines themselves are back to normal. But the cost of general maintenance, for auxiliary equipment and items common to all the engines, has increased to $96 per month—a total of $4119 for the period. A substantial part of this figure is chargeable to using bunker C. Also, the normal maintenance cost for labor and material totaled $24,557. This means that during the worst years, when we were meeting and solving new problems, maintenance due to bunker C was just over 25% of the total maintenance cost.

Sticky sludge. The most obvious effect on the engine is an increase of sticky sludge. This naturally results in higher filter and oil-reclamation costs. It's difficult to figure this cost increase because, with ordinary distillate fuel, the engine can operate with much dirtier lube oil.

Reduction in bearing maintenance has more than paid for the extra cost of filtering the lube oil, and shelling of the babbitt from the backing of bearing inserts has almost ceased now that we've installed full-flow filters.

If sludge is allowed to accumulate in the lube oil, piston rings will stick, causing breakage and excessive cylinder wear. Also, sticking of tappet rollers and fuel-pump crossheads can be the source of much trouble. If the engine is designed so that parts are washed as well as lubricated by the oil, careful attention to the lube oil can lick stickage. This is a point that neither engine builders nor operators can afford to overlook. Failure to recognize and cope with the problem may wreck an engine.

Ash deposit. We call it slag. Picture on facing page shows how it has built up on an exhaust valve. There are also patches of it on the seats, registering with patches on valves.

(*Continued on page* 222)

Karl MacDonald, after 40 years of designing experience, tells you about . . .

Carbon-packing progress for sealing small turbines

► My first encounter with a turbine-shaft carbon-ring packing gland was in 1911 while a draftsman for a turbine firm. My job was designing a set for steam and exhaust ends of a turbine. None of us had ever seen a carbon packing, yet it was to go in a turbine that was on order.

Our standard packing then was a bronze sleeve with clearance between shaft and sleeve bore. Sleeve had flanges on ends to prevent it going endwise. Notch in flange engaged a pin to keep it from turning. This sleeve floated on the shaft and, in time, wear increased steam leakage.

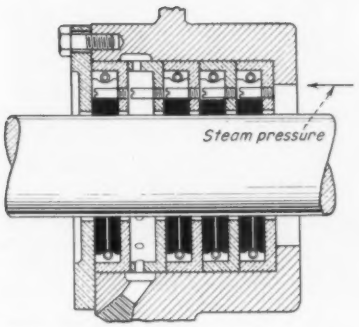
Our turbine was an axially assembled multistage type. So carbon packing had also to be axially assembled in turbine's steam end, while diaphragms and exhaust end had no horizontal joint. My finished design looked like first sketch *on facing page*. L-shaped sections were bronze. Carbon-packing stop was screwed into vertical wall and riveted over.

We knew nothing about carbon at that time so rings were patterned after metallic packing rings on reciprocating piston rods. These have a half-and-half vertical joint on ends of each segment. Ends had a little clearance so tension of garter spring would close them onto shaft. They were 0.003 to 0.004 in. smaller axially than compartment width. Later, we found half-and-half joints a nuisance as they broke in handling, so we used radial-arch bound joint.

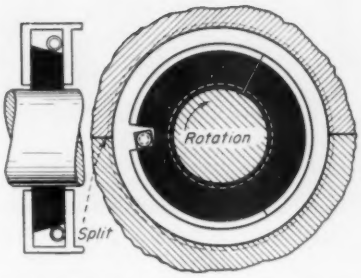
Garter springs were phosphorbronze wire, the only noncorrosive material we had in those days.

It was quite a job assembling the packing as we had all packing compartments on the shaft between the exhaust end and bearing case, and the same on steam end. After we had a couple of rings in place, it was fairly easy to get the rest in place. What pleased me was that it worked much better than bronze sleeves. The chief engineer was satisfied.

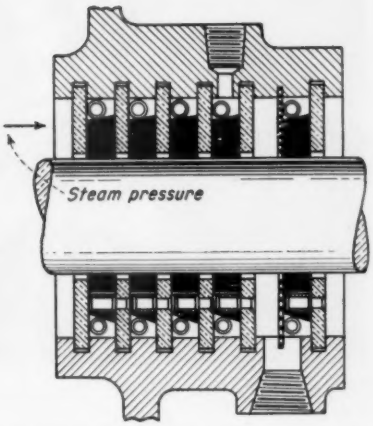
Then I went with another turbine firm as engineer in charge of design. They had a similar design of sleeve packing. But they tried to grease-lubricate it by drilling a hole axially from the outside in end of gland. Engineer



FIRST DESIGN by author: split rings and L-shaped sections between the rings



RADIAL SLOT in latest design prevents segment near slot wearing out-of-round



SLOPING TOP allows spring to hold ring against the sealing face of ring casing

was supposed to give a grease cup a half turn every half hour.

One customer kicked about turbine leaking steam from both ends of turbine. My first job was to design a carbon replacement gland for that machine. There was just enough radial space so I could make a thin bronze axial-split case with integral carbon-ring spacers. It was held in place by clamping action of upper- and lower-half turbine case.

Favorable report on that turbine got management to make replacement packing cases for all turbines of that type in field. We made these of bronze as space was limited. On new designs we used a cast-iron packing case with integral carbon-packing spacers. Space was milled on split at each compartment for a thin-steel packing stop. At first, we used phosphorbronze packing springs, but later changed to monel springs. They stood up much better.

We discarded idea of making carbon rings for steam turbines a close axial fit. Instead, we used 0.020-in. to 0.030-in. clearance. With a close clearance we found residue in steam would cement rings, making them hard to remove from casing. We made bore of rings smaller than shaft, with about 0.010 in. open on one end of butt joints, then let rings wear in.

Today, carbon-ring manufacturers furnish expansion coefficients for their carbons. Now you can figure clearance to allow in ring's bore for shaft fit at given temperature. But sometimes figures lie, for ring's rubbing on shaft raises temperature above what you figured. So don't depend on it.

On single-stage turbines, carbon rings were in three segments with a stop slot on end of one segment. We tried stop slot in middle of segment, but found that assembly men and engineers were breaking them. So we placed slot at ends. On larger shafts, we divided carbon rings into four or six segments and used two garter springs around the rings.

On one small multistage turbine with very small axial length between wheels, we divided ring into four segments, using four packing stops. We recessed for stops and fastened them in with flat-head screws. Garter spring had ends fastened to stops. Then we put the two packing segments in place. Half diaphragm with half packing could be handled as a unit and put in turbine casing.

Another firm used a carbon ring encased on two sides and top with a brass or bronze cover. The three segments were each held against shaft by a leaf spring in middle of each segment. One segment had a radial stop pin in middle. Pin engaged top half of packing case. Design was excellent but expensive, so in 1927 we changed it.

In those days we didn't have nickel cast-iron so we had a lot of scrap packing cases because spacer walls became porous where they joined outside casting wall.

One day the general manager complained about scrappage. He remarked it would be nice if we could get away from rusty spacer walls. I suggested we groove packing case to take circular partitions or packing spacers made of bronze. First we tried it on single-stage. It worked. So we used idea on multistage turbines after that experience.

This design has been used by two other firms since that time. I understand one company had trouble keeping spacers true when machining. Chances are spacer diameter was not thick enough. One large firm made thousands of them.

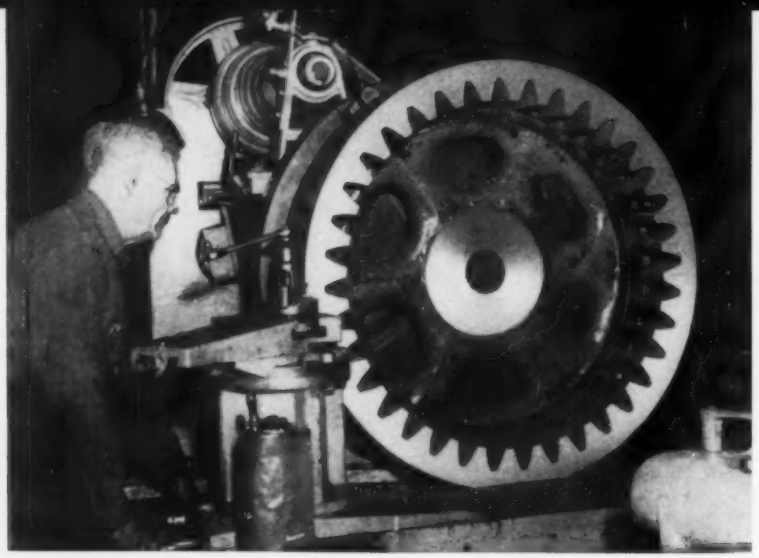
For same size and material, separate spacer deflects more than spacers cast integral with packing case. Also, if centered in packing case by a lip, allow enough clearance for expansion, or they warp.

My invention of the angle-type carbon ring was next improvement. This became known in shop as "side hill" ring. But patent office found a patent had been taken in Denmark about eight months ahead of me.

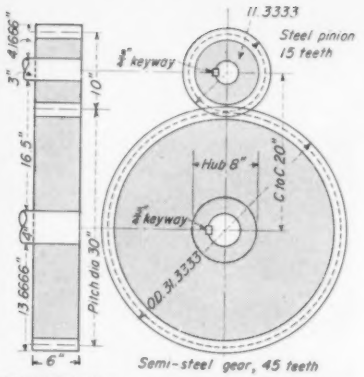
Carbon rings using garter-type springs have a groove around ring's outside to keep spring in middle. Sloping top of ring allows spring to slide down and contact both ring's top and side of spacer. This forces ring against spacer on opposite side, besides holding ring together, *third sketch*. With usual type ring, we had to depend on steam forcing it over for steam seal on spacer's face. Test floor men would often have to hit packing case with a lead hammer to jar rings loose so steam pressure would push them over. With angle-type, spring pressure holds ring in place when steam pressure is removed. For this reason it should have a longer life than regular ring.

Angle-type ring should have a 12- to 13-degree slope. Ring had a lip at slope's bottom for horizontally split packing cases, with integral and solid-

(*Continued on page* 200)



MACHINING replacement gear. This job requires drawing with accurate measurements



SPUR-GEAR measurements. Count number of teeth, measure outside diameters, center distance, tooth width, bores, hubs, keyways; calculate the pitch diameters

Elevator gears gone sour?

Take these measurements for replacements

By W J PRISE and Wm WILLEKE, *The Maintenance Co, Inc*

When gear teeth wear badly, you must replace them—fast. But manufacturer's original drawing of old gears may no longer be available. These five steps help you specify replacements:

1. **Note car capacity and name-plate data**
2. **Make a rough field sketch of the gear arrangement**
3. **Check dimensions accurately**
4. **Calculate dimensions that cannot be measured**
5. **Make finished drawings for the patternmaker, machine shop and your gear cutter to use for fabricating finished gear**

► SPECIFYING REPLACEMENTS for elevator gears is easy if you have access to the manufacturer's original drawings. But if you don't, breaking the job down into the five steps mentioned at the left will help considerably in drawing up specifications.

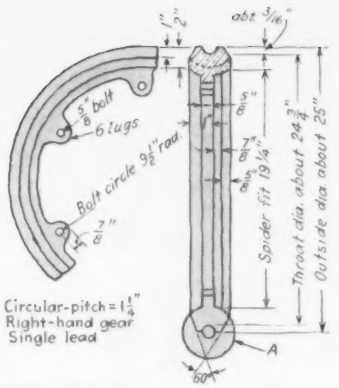
Before we go into details of taking measurements and producing drawings, let's take a look at gear types and common causes of wear.

Usual setups of elevator gears include single worm and gear, and single worm and gear combined with internal or external spur gearing; tandem gears are sometimes used to eliminate thrust problems.

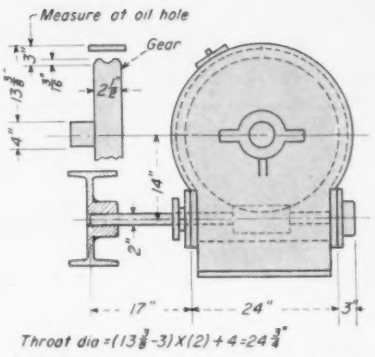
Worm and gear are usually made of different metals. The worm is forged of high-carbon steel, and is often made in one piece with its shaft. Gear is usually special-composition bronze.

Wear in worm-gear drives is caused chiefly by metal-to-metal contact during starting and stopping. During ordinary operation, the worm carries lubricating oil from the supply in its gear case to the teeth of the gear, maintaining a continuous film. When elevator slows down or stops, speed of worm is not high enough to lubricate points of contact properly, and wear results. Other causes of wear are shocks, experienced during abrupt stops, and overload of cars.

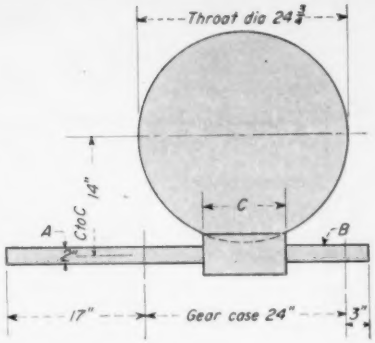
Normal gear life varies, depending on the service. In slow-speed machines gears may be used until they are practically worn out. This may be ten years or over, depending on the service. For machines of higher speed, gears must be replaced before they fail, because play between worm and gear becomes too great for satisfactory performance.



FREEHAND sketch of gear must show all dimensions patternmaker will need, including spider fit and bolt circle. Check the radius of circle *A* on your layout



DETAILS of worm and gear arrangement. Check length and diameter of shafts, bearing positions, gear width, clearance, center distance; calculate throat dia



LAYOUT from field data shows length of worm *C*, should note lead, circular pitch, right- or left-hand operation. Check shaft diameters closely at *A* and *B*

Providing duplicates of the original units rather than creating new gears is the problem of the repair industry. Here's how to measure for replacement, so the new units serve as well as or better than the originals.

1. First step in taking data on elevator gears is to note capacity of car, motor speed and horsepower, size of drum or traction sheave.

2. Next, make a rough sketch representing the gear installation. This should show all important parts of the machine. A drawing made from the rough sketch must give the machine shop all information it needs.

On some machines, you have to remove only the top part of the case to get to the gear ring. On others, there is no easy access. For instance, with gears in the basement, you may have to remove the load before opening the case, if bearing is part of the housing. To remove load, land the counterweights and tie up the car.

Note whether there is good clearance between outside diameter of gear and inside of case. This will be handy info if slight alterations in design are contemplated. Such variations are sometimes desirable and they do not usually affect working characteristics.

3. After making the rough sketch, put the necessary dimensions on it. Check circular pitch by measuring length of arc between a point on the pitch diameter of one tooth and the equivalent point on the next tooth. Measure width of tooth, center distance, length of gear case, distance shaft extends beyond face of the case. Note whether gear is right or left hand, and its lead. This lead can be single, double or triple, and it has a great deal to do with car speed.

One turn of the worm shaft tells you whether the gear moves one tooth, two, three, etc. The number of teeth the gear moves for every turn of the worm indicates the lead.

Check length of housing, extension at rear of housing, diameter of drum or sheave. In general, make sketch of the installation as complete as possible and take all measurements that may be needed in preparation of a finished drawing. See sketches, *above*, for important data to be noted.

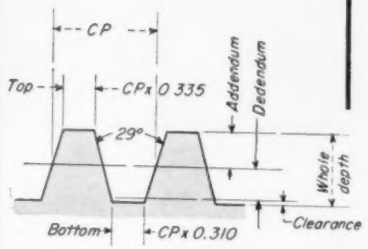
Remember that the worm shaft sometimes extends beyond the brake pulley, directly to the motor bearing. Be careful to note exact length of this shaft. Check diameter of both shaft extensions from the worm; in some installations diameters will be different because of the type of thrust.

4. Next, calculate the pitch diameter, throat diameter, outside diameter of worm. See box, *right*, for easy-to-use formulas.

5. Make drawings for patternmaker, machine shop and gear cutter. In specifying materials for the worm, 35 to 40% carbon steel is recommended. Anything below this gives a soft worm, and results in quick wear and backlash.

A good point to remember in designing the replacement gear is to leave the spider fit full, so final fit can be made in the shop. You will have a loose fit if an allowance has not been made in the design.

After the new parts are made and arrive at the premises, make necessary arrangements to shut down the car, dismantle the machine, install new units, rebabbitt bearings if necessary, replace or provide proper lubrication for all parts, and put the car back into service.



Standard formula for worm and gear

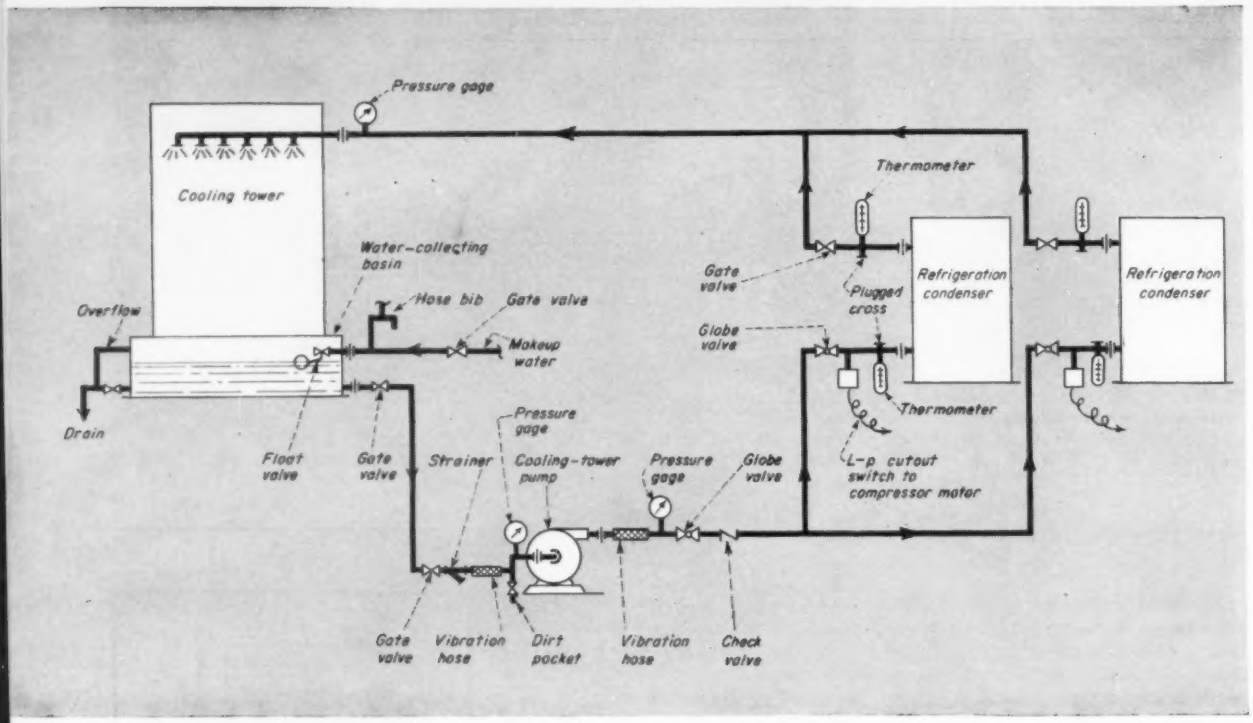
CP = Circular pitch
Addendum (*add*) = Dedendum (*ded*) = *CP* × 0.3183
Clearance = *CP* × 0.05
Whole depth = *CP* × 0.6866

Pitch dia = (No. of teeth × *CP*) ÷ 3.1416
Pitch radius = pitch dia ÷ 2
Diametral pitch = No. of teeth ÷ pitch dia
C to *c* = center distance

Throat dia of gear = pitch dia + (2 × *add*)
or (No. of teeth + 2) × *CP* ÷ 3.1416
or (No. of teeth × *CP*) ÷ 3.1416 + 2 × *add*

Outside dia of worm = (*C* to *c* − pitch radius + *add*) × 2

Note: These formulas are standard for the 14½-deg gears found in many old elevator installations. Check with gear cutter to learn what additional data he needs.



COOLING-TOWER PIPING diagram shows all elements that should be considered for a troublefree refrigeration system

Recent water shortages have forced many localities to prohibit unlimited use of refrigeration cooling water. Even where there is no acute shortage, high cost of water often makes a recirculating system pay off. In either situation you'll want these timely tips on . . .

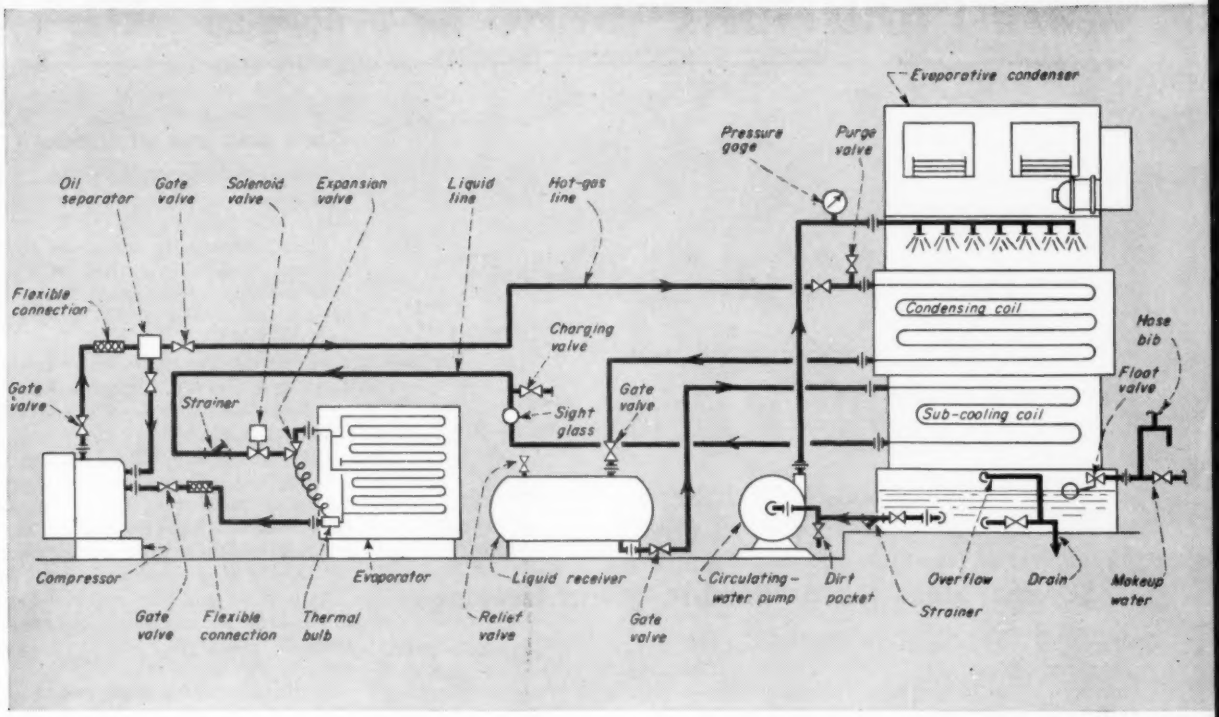
. . . efficient hookup of your cooling tower or evaporative condenser

By **M METZ**, *Installation Supervisor*
S J O'Brien Sales Corp, Frigidaire Sales & Service

► IF YOU'RE ONE of the lucky refrigeration-plant operators who is blessed with an unlimited source of free or very cheap cooling water, you can stop right here. But if you're faced with restrictive ordinances designed to limit the use of refrigeration cooling water, or are trying to hold the line against soaring water bills, here are two practical solutions to your problem—the cooling tower and the evaporative condenser. Both depend on the principle of evaporative cooling for operation.

Cooling tower is usually selected to operate in conjunction with the larger refrigeration plants since they are most efficient when passing large quantities of water. Here's how it works: As the warm water is brought into contact with a moving air stream, a small part of it evaporates. The heat needed to evaporate this water is supplied by the main body of warm water, which is thereby cooled. Try wetting your finger and blowing on it. Notice how cool it feels. This is nothing more than evaporative cooling.

Location of the tower above the refrigeration condenser is preferred. If you place cooling tower below condenser, all the water will drain back to the cooling tower storage basin when pumps



EVAPORATIVE CONDENSER system with subcooling coil makes use of wet-bulb temperature of air to cool the refrigerant

are shut down. A large portion of this water is then wasted through the storage-basin overflow. When the system is again started, the pump draws down the storage-basin water level until air is pulled into the suction, and you're faced with an air-bound pump. Unless someone happens to be around to bleed air manually through vent when this occurs, water-hammer can severely damage your system.

By locating the cooling tower above the condenser, you allow the entire system to act as a water reservoir, thereby eliminating the possibility of drawing down the storage-basin water level when starting up the system.

A pressure gage on the tower spray-header inlet indicates a pressure rise when the spray heads are clogged with dirt or other foreign material, a sure sign it's time to shut down the system and clean the spray heads. It's also smart to put a pressure gage and globe valve at the pump discharge to manually adjust the correct discharge pressure. Often a new system is designed with oversized pipe, so chemical deposits caused by untreated cooling water will not build up pipe friction losses to a point where the pump is overloaded. When such a system is new, it's necessary to manually throttle the discharge pressure to the correct value.

Globe valves at the water inlet to each condenser are a must when multiple condensers are hooked to the same cooling tower. With them, it's an easy matter to adjust flow for proper refrigerant head pressure.

Hose bib is handy where dust and dirt can get into the storage basin and eventually build up a layer of sludge. When this happens, hook up a hose to the bib and flush the storage basin. This bib can also be used to speed up filling the water system before start up.

Thermometers on the water inlet and outlet of the condenser permit you to set water flow on the basis of temperature rise required so refrigerant head pressure and operating temperature are maintained at the correct level. Connect thermometers to plugged crosses to allow temporary hookup of pressure gages. High-pressure drop across the condenser as indicated by the gages is positive indication of a clogged condenser.

Pressure switch in water line at condenser inlet is wired to the refrigeration-compressor motor. If cooling-water flow is cut off because of pump failure or poor valve manipulation, line pressure will drop. When this happens, the low-pressure cutout switch interrupts power circuit to compressor motor. This safety feature has a twofold purpose. First, because refrigerant head pressure rises as cooling-water flow decreases, cutting out the motor prevents blowing of refrigerant relief valves and loss of expensive refrigerant. Even more important, it protects the motor from overload and a possible burnout.

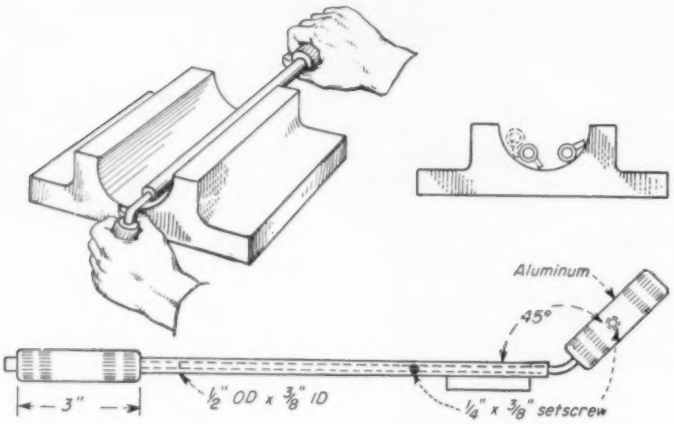
Strainer on the water-pump intake can add years of life to your pump. But if you forget to clean it periodically, you'll be plagued with a clogged line. So set up a routine maintenance schedule and stick to it.

If your cooling tower is induced-draft type, an electrical interlock between fan and circulating-water pump insures automatic cutout of the pump if fan should fail. When electrical switches without interlocks are used, there's always the possibility the operator will forget to stop pump upon fan failure. Result: high refrigerant head pressure, overloaded system and possible blowing of refrigerant relief valves.

Evaporative condenser combines the function of the cooling tower and condenser in one unit. With this arrange-

(*Continued on page* 198)

Newest PRACTICAL IDEAS for a bang-up job to cut



Scraper does job on hard-to-get-at bearings

WE FOUND that the regular-type bearing scraper doesn't do the job when fitting bearings, especially long ones. Mechanic often can reach only one end of such bearings. A long or offset handle on scraper is then needed to reach the far end. But this makes it awkward to exert enough pressure and control on scraper blade. On such jobs, scraper slips and chatters. When the free hand is used to guide scraper's tip, it obscures vision and prevents quick accurate results.

We made a scraper to overcome many of these faults. It is handy for producing a "drag" or scraping cut. When used as shown, scraper will not jump or chatter.

Sketch shows how it's used with equal ease on bearings of largest diameter and length, or on split bearings as small as 1 in. in diameter.

Main grip on body tube may be locked at any convenient position with setscrew. Auxiliary handle is rotatable and slidable in main tube. That permits great force to be exerted with both hands when you have to take heavy, smoothing cuts as on large bearings.

In final stages of fitting, main grip-end of tool may be lowered slightly. By using heel section of blade, fast accurate spot scraping is done with good control. Auxiliary handle may then be turned downwards or sideways and the hand holding this grip rested on some convenient surface.

Heat-treat the high-speed steel cutting-blade before silver-soldering it to body tube. If soldering is properly done at lowest temperature practical, blade will retain plenty of hardness to hold a good sharp edge. Allow assembly to air-cool after silver-soldering operation.

W H THOMAS *Rodney, Ontario*

Care and use of ladders

STORE A WOOD LADDER in dry place, not near radiator, steam line or other equipment where it might get damp. If ladder is placed horizontally, support to avoid sagging. Also, when carried on a vehicle, not only support to avoid sagging but also lash down to avoid chafing and road shocks.

Inspect often and take out of service if damaged, then tag, "Dangerous! Don't use until repaired." Keep grease and oil off rungs.

Place ladder at pitch so horizontal distance from top support to foot is one-quarter of its working length (length along ladder between foot and top support). Place ladder to prevent slipping, or lash or hold in position.

Never place ladder in front of a door, unless it is blocked open, locked or guarded. Don't place ladder on unstable base to obtain more height.

At window opening, to support top of ladder, attach a board across its back, extending across window. That gives firm support against building walls or window frames.

Always face ladder when ascending or descending.

Never use ladder with broken or missing steps, rungs, broken side rails, or other faulty equipment. Never make improvised repairs.

Don't use ladder in a horizontal position as a platform, runway or scaffold. Don't use it as guy, brace or skid.

Minimum overlap for two sections of 2-section ladder is 3 ft for sizes up to 36 ft; 4 ft over 36 ft and including 48 ft. Use at least 5 ft on sizes over 48 ft and including 60 ft.

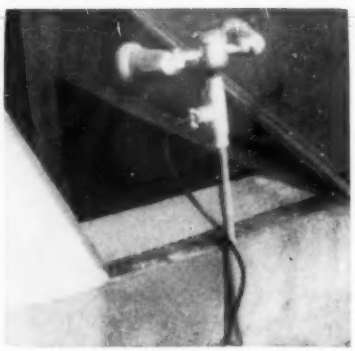
Courtesy, American Ladder Institute

Homemade floodlight

ON PAGE 134, Feb POWER, you ran an article, "Floodlights Protect Our Plant at Night." My snapshot shows a much simpler rig. We use standard parts, nothing to fabricate but spike on double light stand, shade on single one.

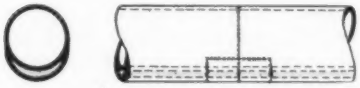
Photo, *left*, shows lighting of one building using buried conduit, Stonco bases and metal shades painted green to match the grass. Other photo, *right*, shows portable rig with a spike for ground and rubber electrical cord.

L F COSGROVE *Raritan, N. J.*

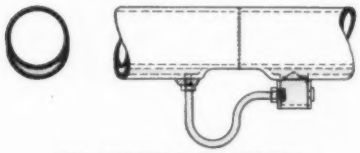


your costs of operation and maintenance

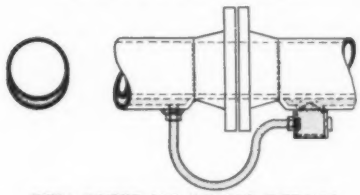
STEVE ELONKA, *Associate Editor*



WELD WITHOUT PIPE FITTINGS OR JUMPERS



USE JUMPERS BUT NO FITTINGS



BOTH JUMPER AND WELDED FITTINGS

New aluminum piping is steam jacketed

PIPING TO HANDLE sluggish chemicals, like tar and pitch, or tricky solutions, like ammonium nitrate, needs heated lines to prevent solidifying or crystallizing in line. In contrast to normal method of heating lines with an external steam jacket or steam tube to apply necessary heat, this steam line is part of the pipe.

Extruded from aluminum alloy as a single unit, new product is slightly oval in cross section because of crescent-shaped steam passage, *sketches*. Heat transfer is greatly improved and expense of steam jacketing is saved.

Preformed insulation fits this new pipe. On 2-in. pipe, new product is designed so insulation for 2½-in. standard pipe forms naturally. With insulation, use smaller size than on older steam-jacketed piping. Because of improved efficiency, thermal insulation isn't often needed, especially where sec quantities of process steam are allocated for tracing purposes. Insulation can be easily formed with conduit tools.

Products suited for handling are molten sulfur, ammonium nitrate solutions, glacial acetic acid, fatty acids, tar and pitch, similar products normally needing steam tracing or steam jacketing.

This piping gives users of steam-traced piping a totally new solution to the various equipment problems that arise in this field. Piping is integrally extruded and engineers will no doubt come up with some novel applications.

Courtesy, Aluminum Co of America

What would you have done?

FIRE BROKE OUT in our powdered-coal plant. Before we could extinguish the flames, they had caused a red hot spot on the conduit carrying the dc current to the separator magnet. Then a short developed, blowing the fuse and putting the magnet out of commission.

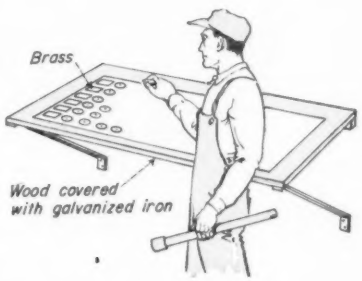
We had to install a temporary circuit immediately for if a bit of steel got by the magnet it probably would have caused a serious explosion in the ball mills. A pair of wires were quickly run from the magnet across the open "fire gap" between the buildings and into foundry to dc and ac feeders.

Each pair of wires was 115 volts, but *which* pair was the dc and which the ac? That was the question and to trace back would take time—time that we could not spare—for feeder belt was delivering coal to the mill over a dead magnet. A bit of steel might come along any instant and do plenty of damage.

Our electrician had a test lamp and needle clamps with him. He quickly picked out the dc wire by a very simple method. He clamped the lamp across one pair of wires. Moment it lit, he waved his hand to and fro in front of lamp and noticed that there seemed to be a lot of hands visible. This effect—it's the stroboscopic vision—told him he had the ac circuit.

Clamping on the second pair of wires also lit the lamp. But this time when he waved his hand he saw only an indistinct smear, so he knew he now had the dc power. He quickly made a temporary connection and the magnet was back in service in what seemed to be only a few minutes. What would *you* have done?

G P PEARCE *Albuquerque, N. M.*



Rack solves burner's sprayer-plate problem

WE HAVE two 65,000-lb-per-hour sectional-header boilers delivering steam at 600 psi and 850 F. Our oil tanker, which has one 15,000-hp turbine, is one of the fastest commercial tankers today, with speeds averaging 19 to 20 knots.

Sprayer plates of our oil burners have to be changed when steam rate of boilers is changed, which happens often aboard ship. Sketch shows rack in fire room for plates. It prevents mixing up tips, and cuts down careless handling, which burrs plates near the tiny holes.

Our boiler loads fluctuate widely, especially in port, while working cargo, which means sprayer plates must be changed often. With this rack, there's no doubt what size of tips are in boilers because a glance at rack tells the story.

Rack is made of brass. This substance is easy on sprayer plate surfaces, and we keep it polished. That encourages firemen to keep tips in best condition. Our rack is installed next to burner bench. Tags at beginning of each row of tips are easy to read, which helps locate proper-size sprayer plates.

D E HALE *SS California*

Press-fitting small parts

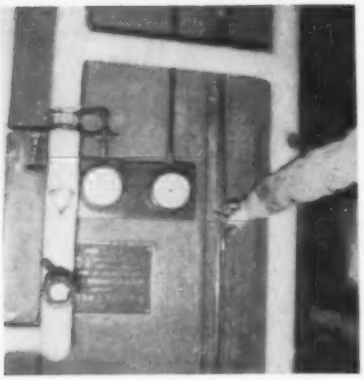
WHEN MAKING a press fit of small parts, lay the male part in the nozzle of a CO_2 extinguisher. Crack the valve for a few minutes. That shrinks the male part. Then slip the cold piece into place. This is fast and handy.

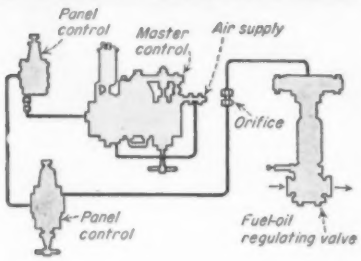
H HOLCOMBE *Los Alamos, N. M.*

(*Continued on page* 130)

More PRACTICAL IDEAS

Begins on page 128





No smoke with load change: orifice did trick

We have two 20,000-lb-per-hr watertube oil-burning boilers. These are automatically controlled by air-operated boiler controls and oil-regulating-valves. Boilers and controls were installed new in 1950 and worked fine at first.

Middle of 1953, trouble started, with dense smoke on every load upswing. Boiler tubes got very dirty. When blowing tubes once each watch, soot would pour from stack, indicating we had been storing unburned carbon in back passes of boilers.

Boiler control system was carefully checked. We cleaned air ports, cleaned and oiled air-power pistons on damper controls, etc. But there was no improvement. Then we decided that oil governor-valve was operating too quickly.

We reasoned this valve was opening to compensate for upswing in load, but that furnace air-controls were not opening as fast. Obvious answer was to restrict flow of air from master control to oil-governor valve.

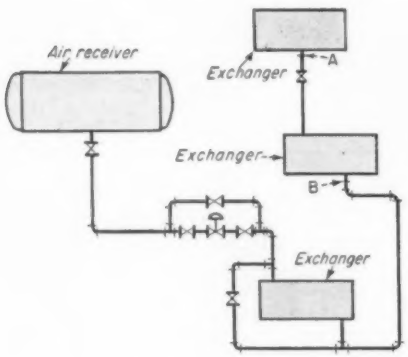
This line is ¼-in. copper tubing, so we made a standard ¼-in. tubing ferrule-type coupling and filled it with solder. We drilled a 0.040-in. hole through the solder, but it didn't work.

We made another with hole of 0.016 in., and a third with hole of 0.013 in. Finally we wound up with holes of only 0.008 in. These gave right amount of dampening to slow action of governor valve. Air-flow regulators now have enough time to swing with governor and we have a well-regulated fire under all conditions. And no trouble with smoke.

Question might come up of these extremely small holes plugging. But this is unlikely as there is no air flow through copper tubing—only pressure change.

S S Thorpe
N. Wilmington, Mass.

Editor's note: This is a good solution but we would still like to know why sudden trouble started after three years of apparently satisfactory operation.



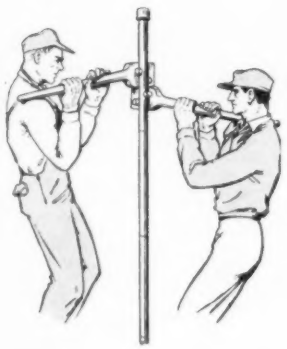
Blowing process lines

Clear process lines of foreign particles by blowing with at least same velocity usually used in the line. Open line at extreme end enough so fluid escapes freely—is not restricted.

Since control valve and first exchanger have bypass lines in sketch, and as second exchanger does not have bypass, blow this system upstream, out through flange *B*. Then after blowing, button up and blow again, this time through exchanger at termination point *A*.

Blow with air, after filling tank with 100-psi compressed air. Also pump some water into line near air tank. Control the flow with valve at air-receiver tank.

M T Pee *Wallaston, Mass.*



Pipe lifters don't cut metal

We recently bought a new rig of specially made sectional steel-pipe, threaded for ease of take-apart. Another feature is that each pipe butts against end of next, so no strain is on threads when driving into ground.

Various boring systems are satisfactory until you start using a lifting wrench like a stillson. But a stillson burrs the pipe sections. My lifters, *sketch above*, do not cut the pipe.

This tool can be made to suit any size piping. It's made in one piece. The "pips" or projections are made round instead of square as a round surface won't mar, yet won't slide over pipe.

D B Clapp *Irvington, N. J.*

Pulling of wrong switches stopped

The automatic voltage regulator cutoff switch and the stator temperature-selector switch are side by side on our panel board. Both have same round handles.

To prevent an operator turning the voltage regulator cutoff switch instead of the temperature selector switch during log reading time, we removed the voltage regulator switch. We then flattened one round side with a hacksaw. Now feel warns an operator when he has hold of the wrong switch on the panel.

U D Roberts *Houston, Texas*

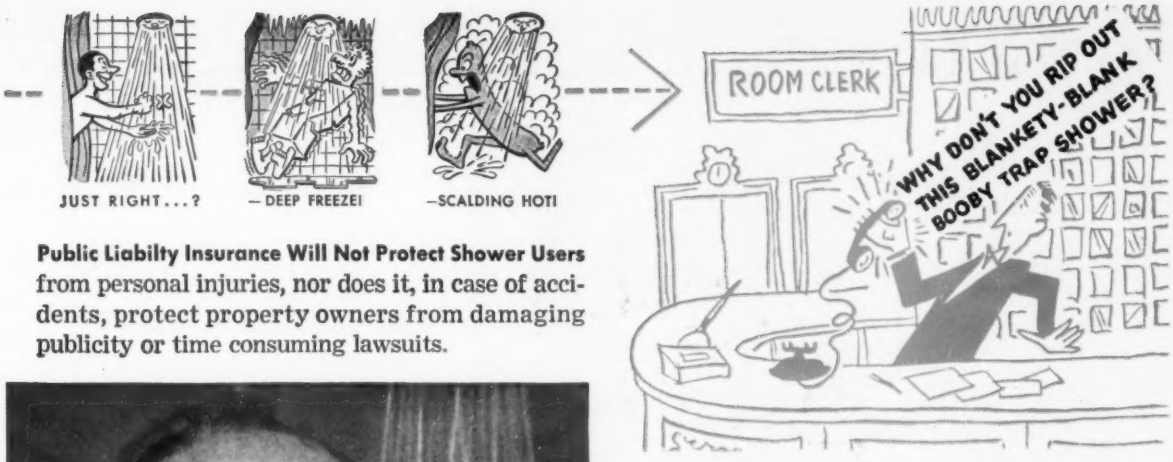
Cleaning and repairing machine threads

For repairing internal threads, get a rod of hardwood and thread it with a die. Screw the threaded wooden rod to clean threads. If threads are worn, coat threads of wood screw with liquid iron cement. Then screw into hole and keep screwing it in and out. This will coat the threads with iron cement.

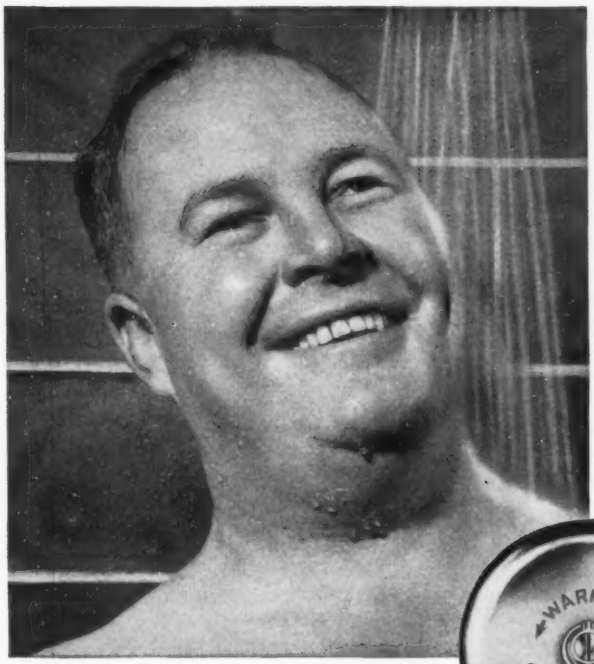
After a few minutes remove wood screw and clean it with wire brush. Just before cement is about set, screw the wood screw in again to smooth any irregularity in the threads.

W E Warner
Woodford Green, Eng.

(*Continued on page* 132)



Public Liabilty Insurance Will Not Protect Shower Users from personal injuries, nor does it, in case of accidents, protect property owners from damaging publicity or time consuming lawsuits.



End Shower Complaints

with

Double-Safety

of

POWERS

Thermostatic WATER MIXERS

They protect bathers from scalding and "shots" of hot or cold water, caused by—

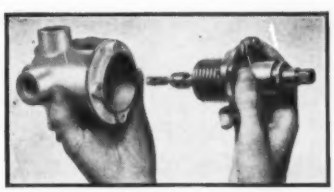
1 PRESSURE or

2 TEMPERATURE

fluctuations in water supply lines

Only a **thermostatic** water mixer gives this **double-safety**

Refreshing, Relaxing Safe Showers
and water economy too, are assured by Powers Thermostatic Water Mixers



One moving part easily accessible from the front. Easy removal of thermostatic motor and valve assembly with only a screwdriver makes it possible to inspect, clean or flush out mixer. Powerful thermostatic motor gives quick, positive shut off if cold water supply should fail.

No Shower Is Safe Without This Double Protection Powers thermostatic water mixers *always* hold shower temperature constant wherever the bather wants it. They are completely automatic. Failure of cold water supply instantly shuts off the shower. Delivery is *thermostatically* limited to 115° F.

POWERS Mixers Save Water. No time or water is wasted by bather having to get out from under shower because of fluctuating shower temperature. Water conservation feature alone makes Powers mixers a profitable investment.

"Minimum of Maintenance" . . . report many users of Powers Type H Thermostatic Water Mixers. Their simple, durable construction insures years of dependable service. (b63r)

For Utmost Comfort, Safety and Economy Install Powers Mixers • Write for Bulletin 365

Established in 1891 • **THE POWERS REGULATOR COMPANY** • SKOKIE, ILL. • Offices in Over 50 Cities

More PRACTICAL IDEAS

Begins on page 128

Securing flexible cable coil

LONG FLEXIBLE CABLE, used for portable electric tools, rarely stays neatly coiled when carried around. Loops of string or insulating tape are OK but take time for placing and removing. My photo shows a simple device to hold a coil of cable. It's easy to make.

Coil holder is a 3/8x1/32-in. springy-steel strip, corrugated with round-nosed pliers.

Lay strip on flat surface and press cable into corrugations. They fill spaces automatically. Coils not secured can be gripped by lifting metal strip and placing it over them. Press into place.

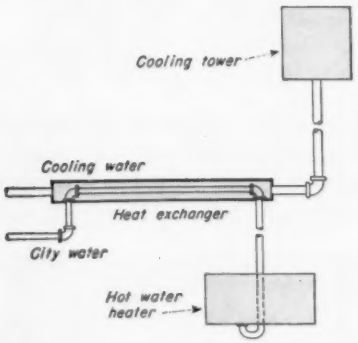
When ready to uncoil cable, pull needed number of coils free and unused coils remain neatly in position.

C T BOWER *London, Eng.*

Burn your holes

USE YOUR WELDING EQUIPMENT to punch holes in steel plate of most any kind. With a little practice you can make holes neatly and quickly, and in most of the sizes needed, without drilling.

ED ECKERT *New York, N. Y.*



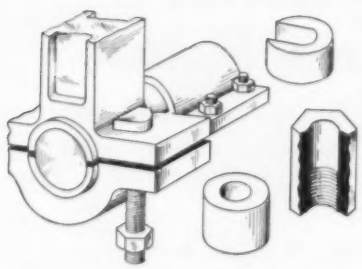
Cooling water preheats hot water

DURING SUMMER MONTHS most buildings use some steam for hot water. Why not obtain some heat energy that's wasted in cooling tower by slightly increasing efficiencies of hot water and the cooling tower?

This would pay off in summer while air conditioning is used and circulating cooling-water from air-conditioning condenser is at higher temperature than city-water supply to hot-water heater. Then water going to hot-water heater should be bypassed to go through a jacket, through which circulating water flows from the condenser to the cooling tower.

Have jacket long enough to act as heat exchanger. City-water supply going to hot-water heater will absorb some heat from the circulating water, and circulating water from condenser will give off some heat. This Btu exchange will increase efficiencies of both hot-water heater and cooling tower.

J M LEPPIN *Irvington, N. J.*



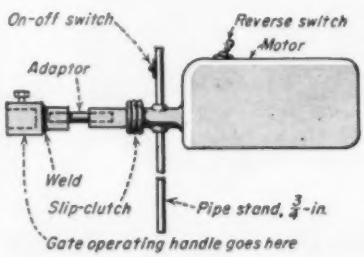
Timesaver for Bearing adjustments

BY USING the spacers shown, you can save time when overhauling equipment like bearings where you use a nut and check nut.

These spacers will save running the first nut on and off the full distance while refitting. After adjusting shims, place the spacer, then tighten nut to try bearing for proper clearance.

If you have much overhauling to do on bearings with long bolts, it pays to make special long hex nuts for these jobs, and use them only while overhauling. Time saved makes them pay.

C H WILLEY *Penacook, N. H.*



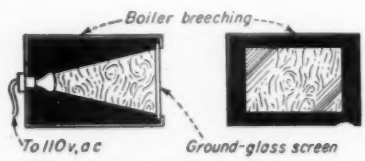
Now, pipe-thread runner closes sluice gates

WE USED an electric threading machine to open manually operated sluice gates. But this proved too cumbersome to move from place to place. Now we have an electric nut runner.

First, we cut gate valve-handles needed and welded a socket wrench to end of each handle. In place of the short 3/4-in. pipe handle on motor, we screwed in a longer pipe to serve as a stand. This arrangement is safe because of integral slip-clutch on runner.

Our pipe runner now does double duty. It cost a hundred dollars.

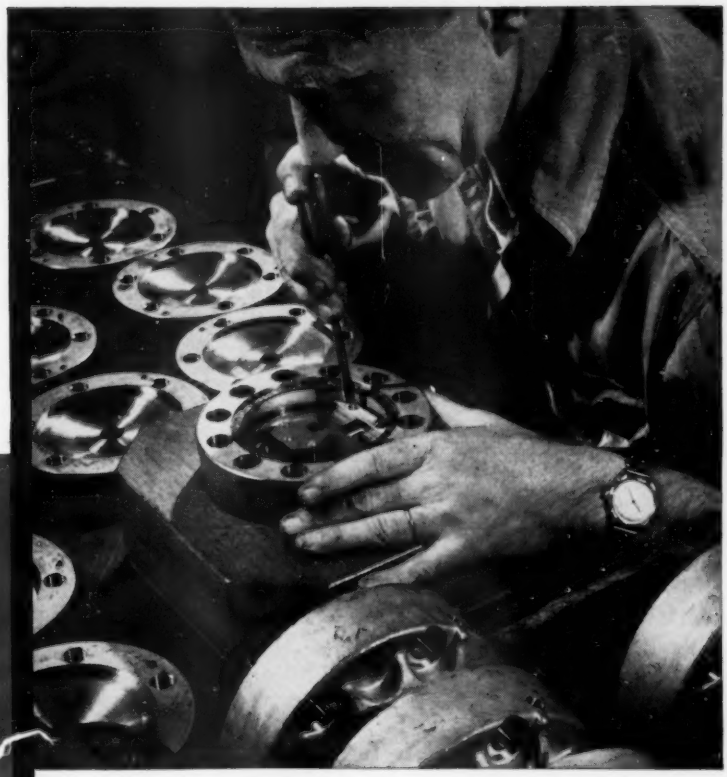
F ARDOLINO *Brooklyn, N. Y.*



Smoke detector helps our firemen

TO CHECK SMOKE in our power plant we installed equipment shown. Spotlight is on one side of breeching and a ground glass "screen" is installed in a hole, cut on the other side. That's all the equipment we use. The "screen" is in full view of the operator in the firing aisle. And our "smoke checker" cost very little. Intensity of smoke darkens or lightens the lighted ground-glass screen.

T HOLLORAN *Toronto, Canada*



Yarway Remote Liquid Level Indicator with new raised wide-vision face. Write for Yarway Bulletin WG-1824.

THIS MAN IS WRITING BOILER INSURANCE

● Figuratively, that is.

He is a Yarway craftsman, assembling Yarway Remote Liquid Level Indicators . . . and the care he is taking is one of the reasons why Yarway Remote Indicators are just about the safest boiler insurance you can buy.

Every part is precision-machined. Every assembled instrument is precision-tested. In the Yarway Research Laboratory a stock indicator passed the equivalent of 100 years normal use with no parts replacements, no serious wear. In thousands of power plants, ashore and afloat, Yarway Indicators are giving similar dependable service.

This is typical. All Yarway products contain the same good engineering and skilled workmanship, aimed at one objective—better service in your plant.

Make Yarway your way.

YARNALL-WARING COMPANY
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steam plant equipment

BLOW-OFF VALVES
WATER COLUMNS AND GAGES
REMOTE LIQUID LEVEL INDICATORS
EXPANSION JOINTS
DIGESTER VALVES
STEAM TRAPS
STRAINERS
SPRAY NOZZLES

PLANT PROBLEMS . . . *helpful info from readers*

What's best scheme to replace lamps?

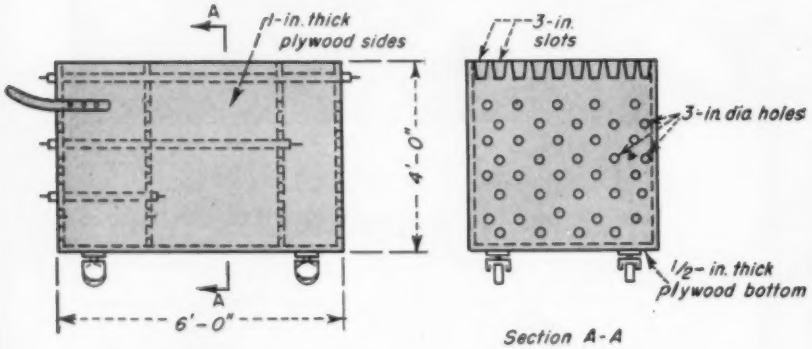
HERE ARE THE FACTS: We have over 7000 fluorescent lamps for production and office-area lighting in our industrial plant. We now replace burned-out lamps on what I call a hit-or-miss basis.

The foreman calls our electrical shop when a lamp burns out in a department. It is replaced as soon as possible. This may be the next day or a month later, depending on how much work the electrical crew has.

Production may be slowed down or stopped during replacement. If another lamp has burned out the electrician must go back to his shop for a second replacement. The whole procedure appears wasteful and expensive.

Will group replacement solve our problems? How are the lamps best transported about plant? ***VC, April Power***

Here are the answers



SKETCH shows a typical arrangement for a truck to transport lamps during group replacement. Slotted plywood supports hold lamps of different sizes. They are easily altered to permit carrying other sizes to the fixtures.

Group replacement is usually cheaper than relamping each time a burn-out occurs. But before deciding to use the group scheme, study your plant to see what is the most economical period between replacements. Once you know this, you can make plans for the best time and procedure for conditions in your plant. Try it and see.

H B Wayne *Brooklyn, N. Y.*

GROUP REPLACEMENT is most effective when lamps are subject to the same voltage variations, and the duty, hours per day, is about the same for all lamps. In other words, the lamps must approach the burn-out point together. If *VC* has these conditions in his plant he'll find that group replacement will reduce burn-outs during production and cut renewal labor costs.

Usually, the best time for replacement is when a batch of lamps attains 85% of average lamp life. From this point on, the lamps fail fairly uniformly, with lives ranging from 85 to 115%.

For example, with 7000 lamps having an average life of 3000 hr, the pattern of burn-outs (neglecting strays) will be such that 1000 will reach 85% life, or 2550 hr; 1000 will last 2700 hr; 1000 will last 2850 hr; 1000 will last 3000 hr; 1000 will last 3150 hr; 1000 will last 3300 hr, and 1000 will last 3450 hr. This is a life range of 85 to 115% of rated, with an average of 3000 hr.

Assuming each lamp costs 50c, and installation cost is 30c on an individual basis and 10c on the batch basis, cost per hr per lamp for lamps renewed at burn-out times is $0.000267; for group replacement at 85% of rated life, cost is $0.000235 per hr per lamp. Group replacement will save you almost 12%.

Strays are lamps that do not conform to the mortality pattern of the larger group. If they are in critical production areas they must be replaced immediately. Elsewhere, they may be replaced when the entire plant or batch is relamped.

Though *VC* doesn't mention lamp cleaning, it requires careful attention. Use a light meter to check lamp output. When it falls to about two-thirds of rated, clean the lamps and their reflectors. If he plans to use group replacement, it can be timed so that it will coincide with the normal cleaning time.

J Howard *New York, N. Y.*

ELECTRICIANS in our plant take care of three buildings, each having about 2500 fluorescent fixtures, each containing two 40-w lamps. Because we have a large number of departments we often have the same trouble *VC* does.

To solve the problem of burn-outs, one electrician is assigned solely to this job and general maintenance. When a burnout occurs he is called by phone or public address system. He is specially trained to replace lamps quickly.

Where a job requires more than one man, help is available from the shop. When not replacing lamps this electrician makes regular rounds of scheduled preventive maintenance.

One of our buildings has high ceilings, 18 ft, and we replace its lamps on a group basis because otherwise we would interrupt production in that building.

Obeno Cuoghi *Richmond Hill, N. Y.*

BUILD A DOLLY and fit it with rubber-tired wheels. Arrange slanted shelves to hold the lamps. Be sure to check plant and lamp dimensions to see the dolly will hold the lamps and can be readily pushed through production aisles, doorways, etc.

Direct the production foremen to report lamp failures twice a day—early in the morning and after lunch. Assign one electrician to make replacements after burn-outs are reported. This arrangement saves time and improves light in the production areas and offices.

Group replacement is best for high ceilings. Don't discard lamps that still burn brightly. Save them for use in fixtures that are easily reached, like shop benches, locker rooms, etc. Group replacement pays where burn-outs slow production or cause other troubles.

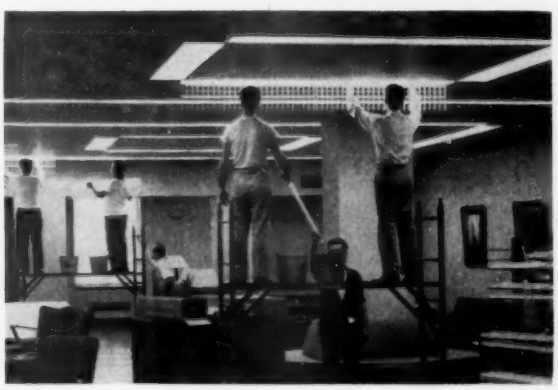
Donald L Cochrane *Milaca, Minn.*

on lamp replacement, ridding belts of static

TYLER HICKS, *Associate Editor*

ELECTRICAL SHOP—headquarters for lamp replacement trucks

IN AN OFFICE the ladders straddle a desk for easier work



LARGE CREWS permit faster and more efficient lamp renewal

PHOTOS, *above,* show a few steps in group replacement of lamps in one plant. Each time we relamp, the louvers are removed and replaced with others that have been cleaned and washed. A new lamp has the installation date stamped on the tube so its life can be checked.

Our studies of the relamping problem show that group replacement gives better over-all lighting, improved appearance and relieves electricians of much routine work. This experience is verified by many other plants in the U.S.

DON KELLAND *New York, N. Y.*

REPLACING LAMPS before they burn out is much like replacing auto tires before they individually blow out. Group replacement is easily handled at a convenient time—usually nights and holidays. This reduces the number of special trips for individual burn-outs.

Starters and ballasts last longer because blinkers are eliminated from the circuit. More illumination is obtained because the fixtures are usually uniform, and a new tube doesn't show up two older ones. Remember, as fluorescent lamps age, illumination falls off.

In our plant, replacement at 75% of rated life, or about 1500 hr, gives best economy for labor and illumination. Lamps lasting longer than this actually waste money because their light production is low for the amount of current consumed.

We use good lamps, removed during group replacement, in spots where their only purpose is for decoration. To handle the lamps during replacement we remove 25% of the number in the cardboard shipping case. This leaves 18 tubes in the case, just enough for easy handling. Burn-outs and rejects are packed in the empty boxes, the ends sealed, and then sledge-hammered. The empty case of boxes is buried.

L W FITZPATRICK
Jefferson City, Mo.

USE TWO MEN to remove fixture covers and lamps during group replacement. Have two electricians follow them, installing new lamps and replacing the fixtures with clean ones. Have a helper supply the new lamps and dispose of the old. Be sure to use a safe means of disposal for old lamps.

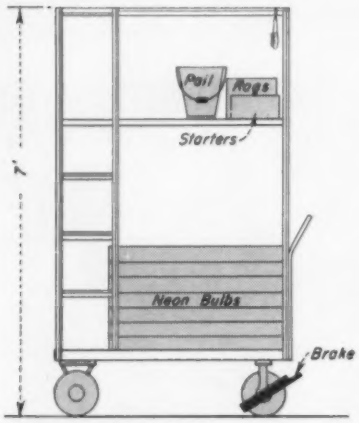
VC should remember that long lamp life goes back to proper design of an installation. Losses from poor design include inefficiency and rapid aging. Provide enough convenient switching outlets to reduce illumination during lunch time and at night. Office and storage areas need be lighted only when illumination is needed. Where burn-outs do not cause excessive trouble, replace lamps at intervals of about every two years, depending on plant conditions.

A J BREUGELMANS *New York, N. Y.*

(*Continued on page* 136)

More PLANT PROBLEMS

Begins on page 134



ROUTINE INSPECTION is a better plan for *VC* than group replacement. Many good lamps might be discarded in a large industrial plant with an extensive installation. Build a truck as shown and have it make daily rounds for both inspection and changing of the lamps.

HOWARD HOLCOMBE
Los Alamos, N. M.

DIVIDE the building into sections, or departments, and replace all lamps in each section at regular intervals. During replacement, pick out the brightest lamps. This is usually about 20% of the total. Destroy the remainder, using a safe means to prevent cuts.

Use this 20% of the total to replace individual lamps as they fail. With lamps rated at 7500 hr, 10% fail at 5400 hr, 20% at 6400 hr. So when the 20% of the lamps saved from each section is used, it is time to replace all lamps in the section because 85% of the life is gone, lumens per watt have dropped 20%, and the remaining 15% life corresponds to a sharp drop in output.

With group replacement, lamp cost increases slightly but labor cost per replaced lamp goes down as much, or more. Also, cleaning the fixtures at the time of lamp replacement increases the savings. Leave tubes in original cartons when transporting them about the building. Use cartons to hold old lamps.

D R CHRISTENSEN
Des Moines, Iowa

CLEAN LAMPS once a year, using specially shaped brushes. Nonflammable fluids are a big help for this job and help speed the work. Two men cleaning 15 lamps per day could make the rounds of *VC's* plant in one year. Where dirt conditions are bad, more frequent cleaning would probably be needed to keep lighting efficiency up.

C G HOWARTER *Canton, Ill.*

(*Continued on page* 194)

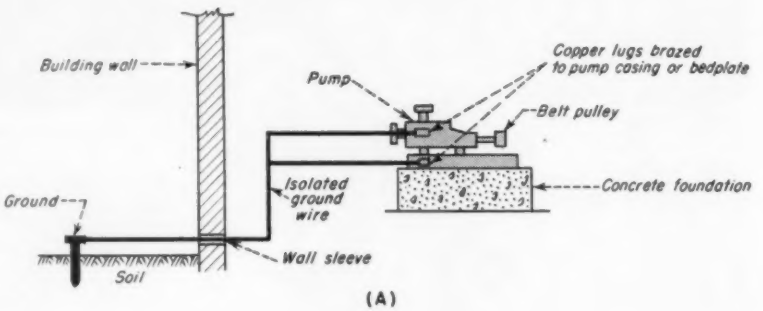
How can we keep static off belts?

HERE ARE THE FACTS: We plan to belt-drive three centrifugal pumps for handling gasoline. We must use belts; no other drives are suitable for the existing conditions. The problem of static has me worried because the explosive hazard may prove too great.

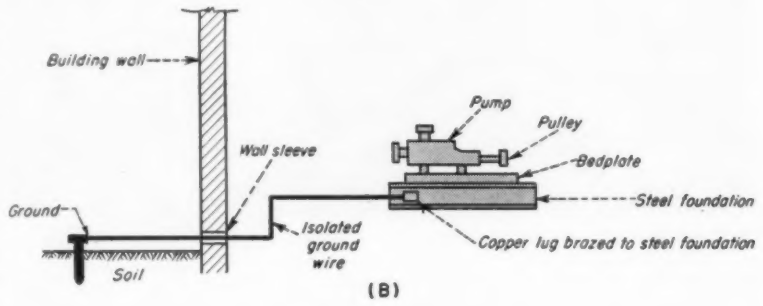
How can we rid running belts of static charges? We'll be able to use either flat or V belts for this drive service.

Are belt compounds suitable for effective dispersion of static charges? What other methods are suitable?—*TA, April Power*

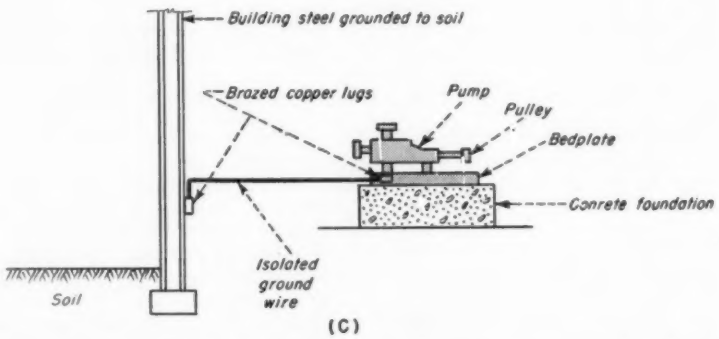
Here are the answers



(A)



(B)



(C)

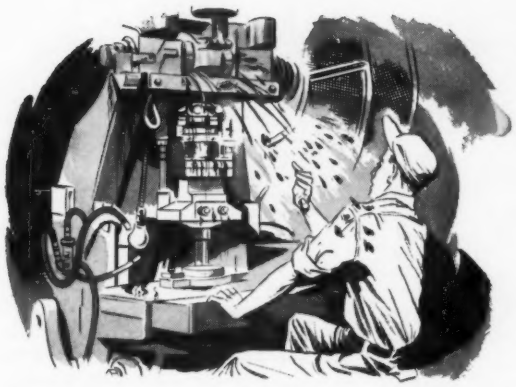
GROUND pump inside a building having a concrete foundation with a connection between pump casing or bedplate and a ground rod buried in the earth, sketch *A*. With a steel foundation for the pump, use the hookup in sketch *B*. When pump is inside a building having grounded structural steel, use the connection in *C*.

Outdoor pumps use a design similar to that in sketch *A* or *C*, but the ground wire is not brought through the building wall. Be sure that in all designs the ground wire is isolated to prevent contact with other equipment, as well as structures and personnel.

H B WAYNE *Brooklyn, N. Y.*

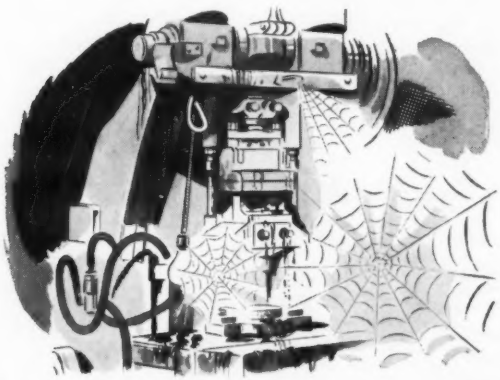
(*Continued on page* 138)

No Downtime in Three Years After Switching to Suntac

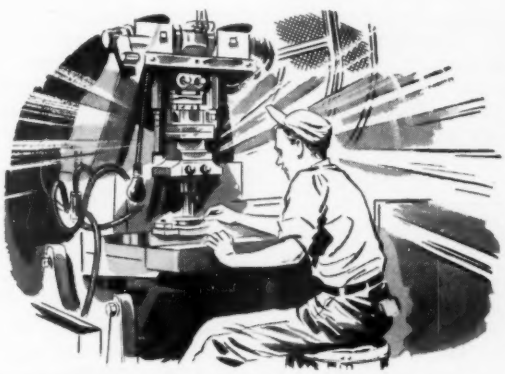


Metalworking firm was using heavy-duty stamping presses of an older type. Bearings were wearing excessively. Oil leaked constantly—on machines, floor and operators.

Lubricant loss was so severe that bearings frequently became so hot the machines had to be shut down until the bearings cooled. This cut sharply into production.



Bearings had to be replaced on an average of once every eight months. Repairs usually took four weeks, and during this time the machines as well as the floor space were completely non-productive.



Manufacturer switched to SUNTAC because it's especially compounded to cut leakage. No breakdown now for over three years. Oil consumption reduced 50%. Also using SUNTAC to lubricate other equipment.

Do you have machines with worn, leaky bearings? Or are you losing oil through excessive throw-off from rotating or sliding parts? SUNTAC is especially compounded to reduce drip, splash and squeezeout. Its greater adhesiveness makes it cling firmly to the parts it lubricates. Get all the facts about SUNTAC from your Sun Oil representative. Or write Dept. P-7.

INDUSTRIAL PRODUCTS DEPARTMENT

SUN OIL COMPANY

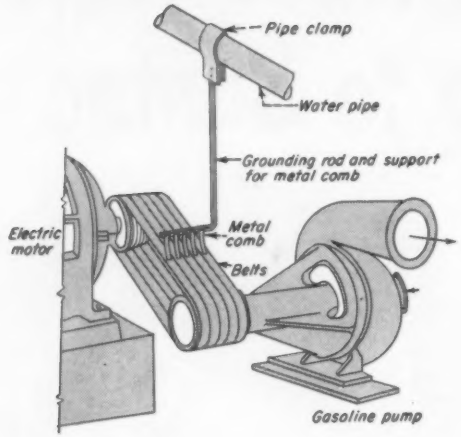
SUNOCO®

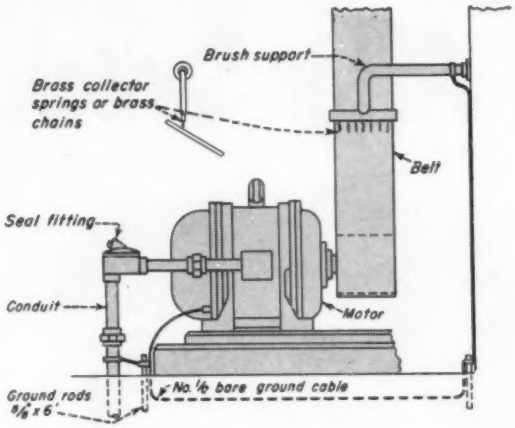
PHILADELPHIA 3, PA. • SUN OIL COMPANY LTD., TORONTO & MONTREAL

Refiners of famous High-Test Blue Sunoco Gasoline

More PLANT PROBLEMS

Begins on page 134





USE A METAL COMB like that in the sketch. The flexible metal strips rest on the moving belts and effectively depolarize them.

Static in belts comes from friction of belt fibers on each other as they bend around sheave, friction caused by belt stretch and contraction, slip or creep on sheave and air friction on the belts.

Contact and separation between belt and sheave generates static. Since the materials are dissimilar, a potential difference is built up with the belt acting as a condenser. These charges dissipate along the belt edges as it leaves the sheave. Charges are more likely to accumulate in dry atmosphere.

Comb in left sketch conveys charges from each belt to the ground through the support rod. Attach rod to a clean pipe. Be sure to install grounding system so it is well protected and will function when needed.

Other methods are available to prevent static buildup on belts, but they are not as reliable. Conductive compounds will work, but it is almost impossible to tell when they must be reapplied to the drive's belts.

A J BREUGELMANS *New York, N. Y.*

SKETCH shows an approved static discharge method for belt-driven machinery. New bulk-gasoline transfer plants use controlled humidities in the transfer-pump area. This reduces the danger of static on high-speed machines in dry atmospheres. It is general practice to locate units outside the hazardous area.

Be sure to check any pump installation in a hazardous area with your electrical-code inspectors. This eliminates many future headaches when the insurance inspectors come on the job.

L W FITZPATRICK *Jefferson City, Mo.*

YOUR NEW PROBLEMS FOR JULY

1 How can we protect boiler furnaces?

We're planning a boiler installation in which gas-fired units will burn about one million cu ft of gas per hr. In addition, each boiler will also burn pulverized coal, either alone or in combination with the gas.

What automatic, semi-automatic or flame-failure devices are needed in these units to prevent furnace explosions from (1) flame failure (2) lighting off (3) switch-over from gas to coal, or the reverse? Can these devices be justified on the basis of insurance savings we will gain? Will they increase our maintenance and inspection work to the point where insurance savings are wiped out?—*EK*

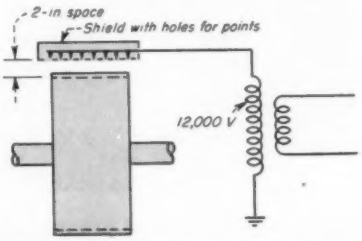
2 What's best way to stop coil freezes?

Cooling coils in our air-conditioning system froze twice last winter, leading to repair bills totaling $3200. We feel that this money was a complete waste because freezes should not occur.

Both times we drained the coils and blew out legs and pockets with high-pressure air. But we now believe the air bubbled through the water in the pockets instead of lifting it because each freeze occurred in a pocket and caused a split coil.

How can we prevent freezes next winter? Filling the coils with antifreeze isn't practical because there are a few days every winter when our plant needs some air conditioning.—*SP*

Will you help readers who sent us problems? Extra pay for photos or sketches.



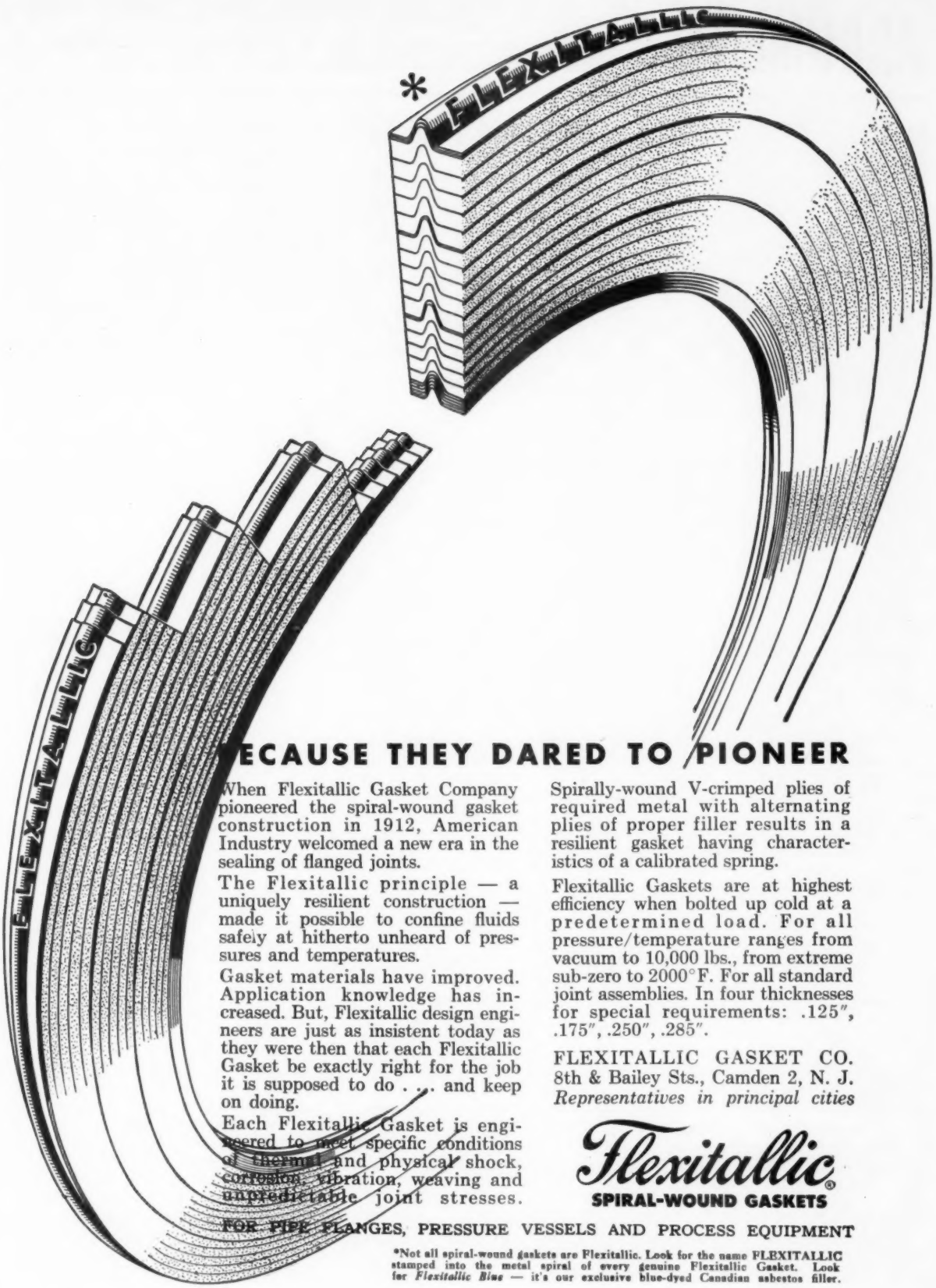
NONSTATIC BELTS and belt dressing are available from belt manufacturers. Or a high-voltage sign transformer can be connected, *as in the sketch.* No matter what removal method *TA* uses for static charges, he should be certain to ground the moving parts of the pump separately through a metal spring contacting the shaft. Pump body must also be grounded.

E A ROBERTS *Carlsbad, N. M.*

ANTISTATIC V BELTS can be purchased for this work. They do an excellent job of eliminating static. A resistance of 0.02 megohm per cm of length safely disperses static charges.

J BARTON *Rochdale, England*

(*Continued on page* 194)



ECAUSE THEY DARED TO PIONEER

When Flexitallic Gasket Company pioneered the spiral-wound gasket construction in 1912, American Industry welcomed a new era in the sealing of flanged joints.

The Flexitallic principle — a uniquely resilient construction — made it possible to confine fluids safely at hitherto unheard of pressures and temperatures.

Gasket materials have improved. Application knowledge has increased. But, Flexitallic design engineers are just as insistent today as they were then that each Flexitallic Gasket be exactly right for the job it is supposed to do . . . and keep on doing.

Each Flexitallic Gasket is engineered to meet specific conditions of thermal and physical shock, corrosion, vibration, weaving and unpredictable joint stresses.

Spirally-wound V-crimped plies of required metal with alternating plies of proper filler results in a resilient gasket having characteristics of a calibrated spring.

Flexitallic Gaskets are at highest efficiency when bolted up cold at a predetermined load. For all pressure/temperature ranges from vacuum to 10,000 lbs., from extreme sub-zero to 2000°F. For all standard joint assemblies. In four thicknesses for special requirements: .125", .175", .250", .285".

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8th & Bailey Sts., Camden 2, N. J.
Representatives in principal cities

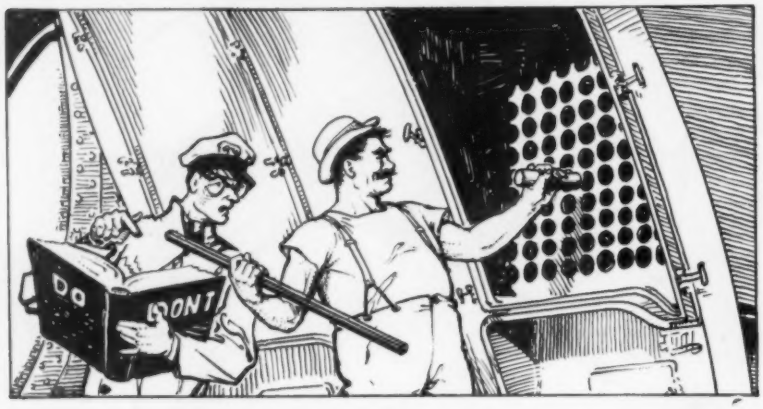
Flexitallic®
SPIRAL-WOUND GASKETS

FOR PIPE FLANGES, PRESSURE VESSELS AND PROCESS EQUIPMENT

*Not all spiral-wound gaskets are Flexitallic. Look for the name FLEXITALLIC stamped into the metal spiral of every genuine Flexitallic Gasket. Look for *Flexitallic Blue* — it's our exclusive blue-dyed Canadian asbestos filler.

ARGUMENTS

Want to start something? Like to have your say about any article in Power? This department invites all comments



Questions the merit of emergency tube repair

IN THE MAY ISSUE, Bill Davis tells in "Practical Ideas" how he plugged a leaking boiler tube in a steam crane by inserting a soft pine plug in the tube. This temporarily prevented water from flooding the firebox, he says.

I don't know what boiler codes or laws were in effect at the time, but this certainly is not recommended.

It's largely a matter of luck whether the plug will hold. Any vibration, quick change in feedwater pressure or force due to sudden load pickup could lead to dislodging the plug.

To the best of my knowledge, state laws, municipal and local ordinances, as well as insurance underwriters, would prohibit such makeshift repairs.

I do not believe any responsible engineer would undertake such a practice regardless of the pressure, temperature and firing rate of the boiler. Recommended procedure is to kill the fire immediately and make proper repairs.

H B WAYNE *Brooklyn N. Y.*

EDITOR'S NOTE: *Soon as we read this letter, we hot-footed over to our consulting engineer, Marmaduke Surfaceblow, Esq. Here's his learned opinion:*

"BILGEWATER on recommended procedures! Tell Reader Wayne you don't run for the book while the ship sinks.

"I've plugged many boiler tubes with pine plugs out in the middle of the ocean when we had to keep going until we hit port. The boilers carried up to 200 psi. They always got us into port—and that's all an emergency repair is supposed to do. Load changes have nothing to do with this case, and I'll bet ten pounds of steam to a bottle of Sandpaper Gin that many old POWER readers have made this repair in a pinch."

More on calculating chimney height

Regarding the question of right datum line for calculating chimney height (March "Arguments"), draft produced by a stack is the result of density differences between a gas and the ambient air.

Density of combustion gas in the furnace and boiler is less than that of the ambient air, and the unit itself acts as a stack to produce draft. As the unit never produces enough draft to overcome the losses, you need an additional stack to make the gas flow over the boiler with the velocity required.

Draft losses in boiler and breeching may be about 8 in. of water. If the boiler can produce, say only 0.2-in. draft, the stack must produce the rest.

You can then calculate stack height from grate elevation with the gas at a mean temperature close to that at which it leaves boiler. Uncertainties due to friction factors, air infiltration in the stack, and wind velocities may require use of factors for calculating height and will further reduce the error of neglecting the high temperature of the gas that is within the boiler itself.

F M BRUNN *Huntington, N. Y.*

EDITOR'S NOTE: *This subject is so interesting we are planning a timely feature article on it. Keep your eye peeled.*

"Bilgewater on weighty fish!"

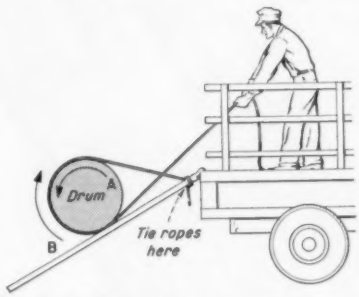
I just read the account of water-screen damage at Avon Lake Station (p 126, March POWER), claiming that weight of dead fish collapsed the intake screens.

If you ask me, Marmaduke should see this article. I'm sure he would say, "BILGEWATER on weighty fish!"

And here's how he'd analyze the situation: Fish cover the screens and restrict flow of water. Meanwhile, circulating pumps remove water below the screen, creating a high hydraulic head.

The baskets on the water screens, being designed for only a few inches head differential, are crushed by the static head imposed because the fish are blocking the water passage.

P E HEIDMAN *Detroit, Mich.*



Is this the best way to handle heavy drums?

The method for handling drums safely by passing two ropes *under* and *over* them (p 138, May POWER) has definite advantages. But I think it misses an important point: Weight and holding power of the operator determine the degree of safety.

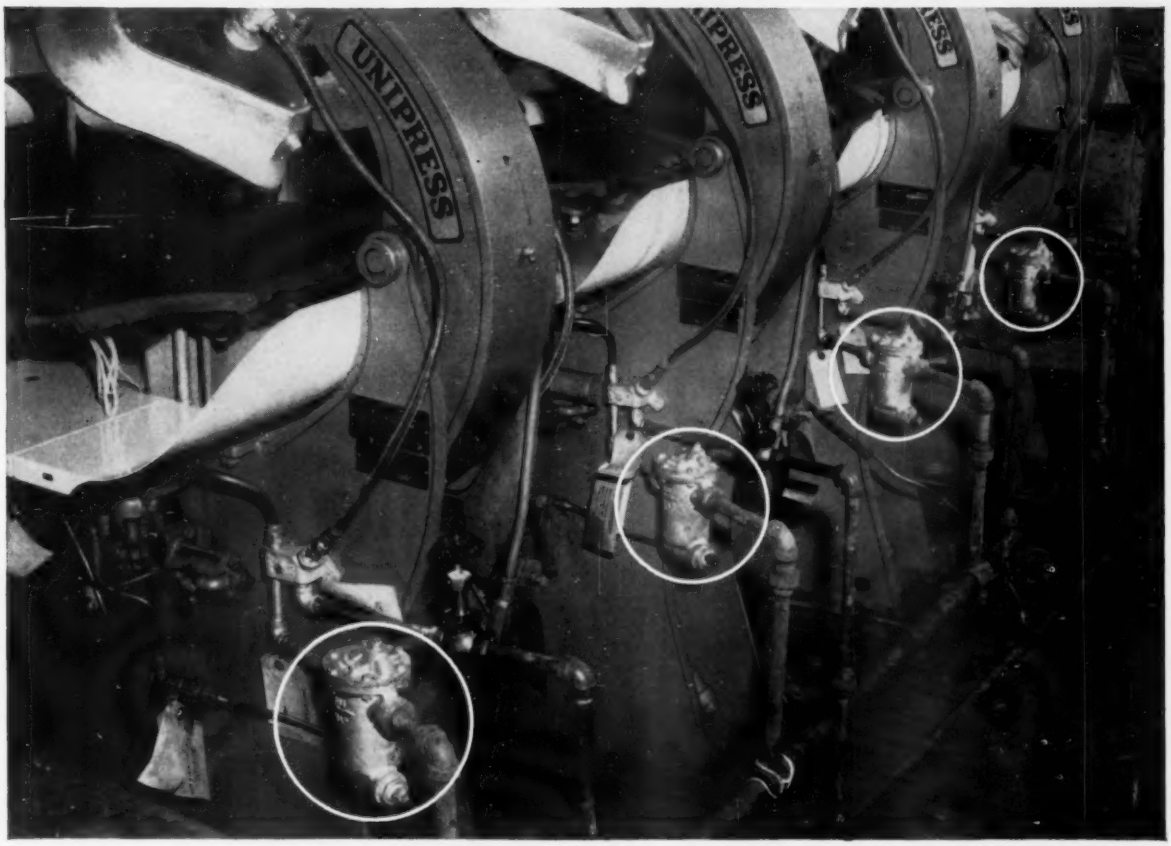
A standard 55-gal oil cylinder may weigh several hundred pounds, and the operator might have to resist over 25% of this weight, depending on angle of the ramp. Rope friction is negligible in restraining drum, as ropes will not slide on it but will roll with it.

I propose a safer, more effective method. Instead of passing two ropes under and over, as above, run them *over* and *under* (*sketch*). Rolling action is indicated by arrow *A*, unrolling action of rope is in opposite direction *B*.

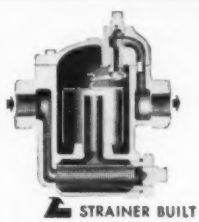
Cylinder cannot roll until you have enough slack to permit it to slip within the rope coil. As about two-thirds of the circumference is circled, frictional resistance to rolling is very great.

LOUIS KASPER *Philadelphia, Pa.*

You can't save money by skimping on Steam Traps—
An Armstrong Trap *on every unit* always pays dividends



Plant doubles production without appreciable increase in fuel costs



STRAINER BUILT IN

Built-in Strainer Traps save fittings, labor, maintenance. Cost less than separate trap and strainer. Complete data in literature mentioned below.

When Standard Coat, Apron & Linen Service took over a previous linen service plant in Portland, Maine, the boilers could hardly handle the steam load. Mr. Tom Foley, General Mgr. called Files Steam Specialty Company, Armstrong Trap Representative in New England, to help correct the condition.

Under supervision of Mr. Ken Raymond, Chief Engineer, Armstrong traps were installed on *each* unit in the plant.

Results: doubled production with no appreciable increase in fuel consumption; higher machine temperatures; boilers easily handle the load.

This is a typical example of the efficiencies and economies possible through Armstrong unit trapping. Could your plant stand a shot in the arm? Call your Armstrong Representative, or write:

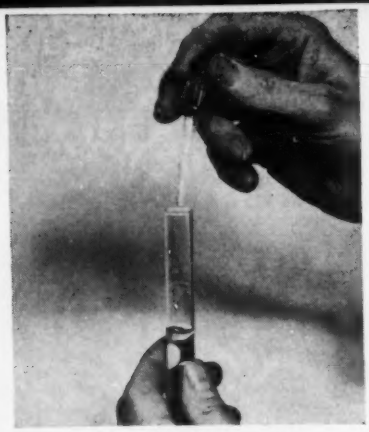
ARMSTRONG MACHINE WORKS
812 Maple Street, Three Rivers, Michigan

SEND FOR FREE CATALOG

—The "Steam Trap Book" contains 44 pages of trap data—selection, maintenance, trouble-shooting. Free on request. Or Consult Sweets or CEC.

ARMSTRONG STEAM TRAPS

1 For pH test, fill two tubes to mark with water to be tested. Test set is for pH, phenolphthalein, alkalinity, total alkalinity, chlorides and also for hardness tests



For hardness, add soap . . .

shake tube . . .

2 Add two drops pH indicator to water sample in comparator left-hand tube

3 Shake tube, rotate dial until colors match on both tubes, read pH on dial

look at lather

NUMBER OF DROPS to give lasting soap lather is grains of hardness per gallon

HOW TO

make simplified water tests

► THIS SET is for pH, phenolphthalein, alkalinity, total alkalinity, chlorides and hardness tests. For pH test, fill two test tubes to mark with water sample. Put these tubes of water in holders of pH comparator shown. Add two drops of pH indicator to tube on left.

After mixing pH indicator with water, rotate color dial on back of comparator until colors match. Dial has colors and numbers that show through window in back of right-hand tube. Read pH of sample from dial. Range covered is from pH of 3.0 to 11.0. Fill test tube again, add two drops of phenol. Tilt back and forth to mix contents. If phenol makes water red, add acid, drop by drop until red vanishes. Shake after each drop of acid, and count the drops. Number of drops used is phenol alkalinity in grains per gallon. Reagents for all tests are of right strength so drops give answer without calculations.

Hardness is determined by adding soap solutions, drop by drop, until a lasting lather forms. Drops added to produce a lasting lather represent grains of hardness per gallon. *—Courtesy, North American Mogul Products Co.*

When something's got to give
to compensate for expansion,
contraction, vibration, rotation or strain,
in your piping system or equipment,
it will be far, far better for you
if the "something" that gives
is a Zallea Expansion Joint
and not your expensive piping.
Since piping damage usually
means down-time, it pays
to provide positive, over-all protection.

The expansion joints illustrated,
duo-equalizing, hinged, and universal,
are just a few of the Zallea family
of expansion joints available
to help solve ycur piping problems.

Regardless of piping movement,
whether axial, lateral, rotational,
etc., Zallea already has, or will
design, an expansion joint to absorb it.
For information on standard types,
request Bulletin 351. For consultation
on special problems, ask us to
have our representative call.

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expansion joints

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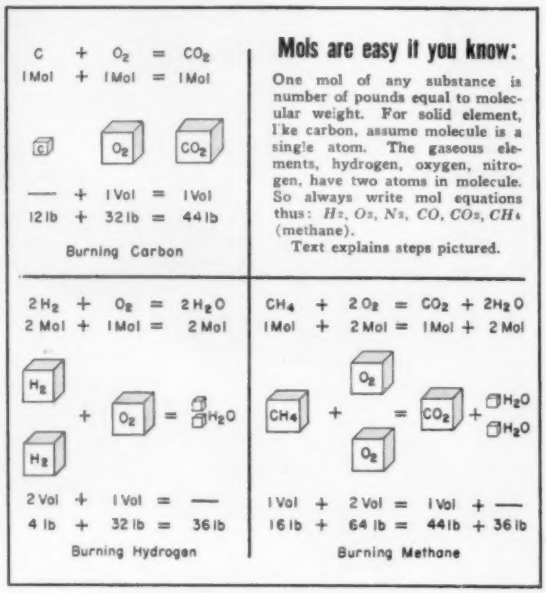
World's Largest Manufacturers of Expansion Joints

HEADWORK

PHIL SWAIN BRINGS ENGINEERING THEORY DOWN TO EARTH

← 1 Mol of any gas equals 379 cu ft	Molecular weight	Pounds in 379 cu ft
H_2	2	2
O_2	32	32
N_2	28	28
CO	28	28
CH_4	16	16


C + O2 = CO2
1 Mol + 1 Mol = 1 Mol
C
O2
CO2
— + 1 Vol = 1 Vol
12 lb + 32 lb = 44 lb
Burning Carbon
2 H2 + O2 = 2 H2O
2 Mol + 1 Mol = 2 Mol
H2
H2
O2
H2O
2 Vol + 1 Vol = —
4 lb + 32 lb = 36 lb
Burning Hydrogen
CH4 + 2 O2 = CO2 + 2 H2O
1 Mol + 2 Mol = 1 Mol + 2 Mol
CH4
O2
O2
CO2
H2O
H2O
1 Vol + 2 Vol = 1 Vol + —
16 lb + 64 lb = 44 lb + 36 lb
Burning Methane

Mols are easy if you know:

One mol of any substance is number of pounds equal to molecular weight. For solid element, like carbon, assume molecule is a single atom. The gaseous elements, hydrogen, oxygen, nitrogen, have two atoms in molecule. So always write mol equations thus: H_2, O_2, N_2, CO, CO_2, CH_4 (methane).

Text explains steps pictured.

Combustion Facts–5:
The easy mol system

► LONG AGO Avogadro discovered that a given volume of one true gas has the same number of molecules as the same volume of any other true gas. This is for a constant pressure and temperature. It follows that weight of a given volume is proportional to the weight of one molecule.

If the volume happens to be 379 cu ft (at 14.7 psi abs and 60 F) the weight of any true gas in pounds is the same as the molecular weight.

In the mol system, preferred by chemists for practical reasons, you first write the chemical equation. Be careful to show the correct formula for each molecule (see notes under "Mols are easy"). Below this you write 1 mol for each molecule.

To get weights in pounds you allow one molecular weight for each mol. Finally, if you are interested in volumes, you allow one volume (379 cu ft) for each mol of a true gas.

Equations, *at left above*, show how this works out when burning carbon, hydrogen and methane (CH_4, which is the chief constituent of natural gas).

A few explanations are in order. First note that no attempt is made to indicate the volume of carbon or water, since these are not gases. The volumes are merely pictured as being too small for us to bother with.

The next thing to note in the mol system is that solid elements, like carbon and sulfur, should be shown as one atom per molecule, thus: C and S.

Gaseous elements, such as hydrogen, oxygen and nitrogen, are known to have two atoms in the molecule and so must be written H_2, O_2 and N_2.

In the equation for the burning of hydrogen it is clear that you have to put a 2 before the H_2 to get twice as many hydrogen atoms as oxygen atoms. Then you have to put a 2 before the H_2O to make the equation balance, left and right. To check the balance, note that each side of the equal sign has 4 atoms of H and 2 atoms of O.

In burning any gas (such as CH_4) containing both carbon and hydrogen, first write the equation without coefficients. On the left side, put one molecule of the fuel gas and one of oxygen. On the right side, put one molecule of CO_2 and one of H_2O, because some of both will be produced. Then juggle the coefficients to make the numbers of each atom balance, left and right.

Now for some conclusions. We see at once that:

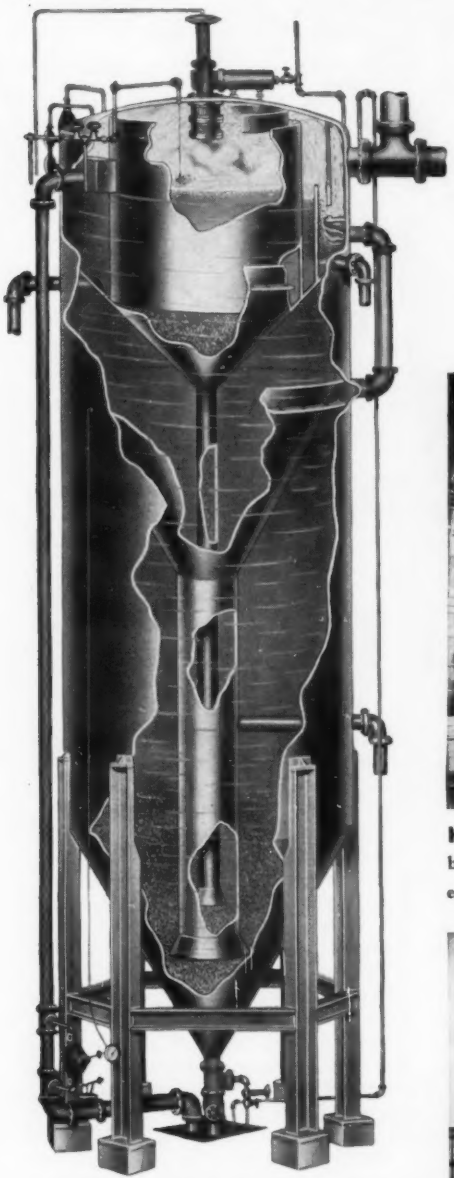
1. When carbon burns, the volume of CO_2 produced equals the volume of oxygen consumed.

2. Two volumes of hydrogen burn with one oxygen to produce a negligible volume of liquid water.

3. One volume of methane burns with two volumes of oxygen to produce one volume of carbon dioxide and a negligible volume of liquid water.

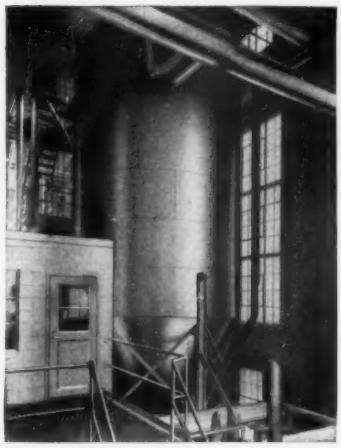
In Hot Process Softening, too

BELCO Builds a Complete Line-

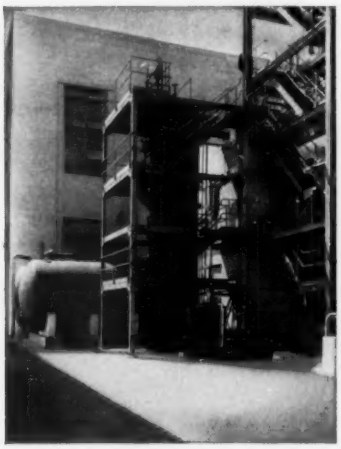


Illustrated literature "Belco In Pictures" is available on request. Write for copy, today.

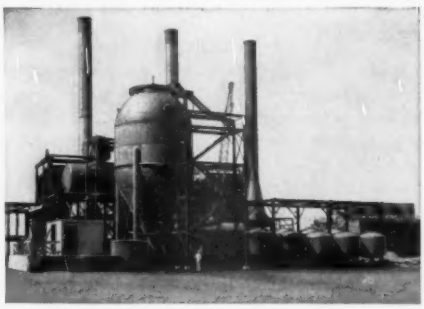
Belco-designed equipment provides high operating efficiency at low operating costs. Many of the country's largest industries rely on Belco for their water conditioning equipment. For example, Belco has built the largest fully automatic demineralization plant in the world and is currently furnishing one of the largest hot lime zeolite installations. A consultation with Belco could lead to lower operating costs for you, too. Write or call for technical assistance at any time.



HOT LIME SODA — Installation in boiler house at large eastern oil refinery. Has capacity of 200,000 lbs/hr.



HOT LIME SODA — Installation in large southwestern utility. One of three units with 90,000 lbs/hr total capacity.



HOT LIME BELCOLITE — Installation at large southern chemical company. Capacity 600,000 lbs/hr. This plant embodies "thoroughfare" operation of separate deaerator and hot process tank. The large hot process tank was designed, built and erected by Belco under its contract with customer.

Belco

Processes for Removal of Water Impurities

Boiler Feedwater Heaters • Water Softeners • Filters • Clarators
Demineralizers • Automatic Process Control Panels

BELCO INDUSTRIAL EQUIPMENT DIVISION, INC.
110 PENNSYLVANIA AVENUE, PATERSON 3, N. J.

REGIONAL OFFICES: *Philadelphia, Pa., Chicago, Ill., Houston, Texas*
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BELCO DESIGNS, ENGINEERS & FABRICATES WATER PROCESSING EQUIPMENT

"I guess you're gonna tell me you're building a blimp and not a Quonset hut," snapped the delegate, blowing his gasket

Marmy strikes oil in Texas

► "BILGEWATER ON SEALS," roared Marmaduke Surfaceblow when I showed him my 20-page handbook on 'Gaskets' in the March issue of POWER. "I'll tell you about building a pressure vessel and I didn't need any gaskets to make *that* job pressure tight."

This outburst took place when that unpredictable consulting engineer and globe-trotting marine engineer came up to our office to look over his three months' accumulation of fan mail. I didn't expect him to sound off but he did—and here's his story, exactly as he told it.

"Back in 1943 I was in charge of maintenance at an old oil refinery down in Texas. The plant included crude and bitumen distillation with atmospheric and vacuum sections, a thermal cracking unit and gas processing. Crude capacity was only 20,000 barrels a day but they planned to expand.

"During the depression the refinery had been shut down and she suffered severe damage from corrosion. I had sailed as chief engineer on the firm's tankers and was hired with a gang of maintenance men to put the refinery back on her feet.

"One big job was replacing the old-fashioned bolted-joint piping with welded joints. I soon learned my gang did the best pipe welding in that part of Texas. We worked on the piping all winter and by spring were down to the pump house used for loading ships. When all the heavy work was finished, the boss surprised me by saying I'd have to lay off my welders. But I liked those boys and had other ideas.

"One thing that refinery needed was a first-class maintenance shop to keep its production flowing as business picked up. The works manager was a good oil man but he had a lot to learn about maintenance. My plan was to build a large Quonset hut, about 100 ft wide by 200 ft long, and to stock it with machine and hand tools. Then I'd be able to work out a preventive maintenance program.

"We had enough old 2-in. piping for the framework. And my welders could do that job while I worked out a schedule to keep them busy after they finished the shop. But to put my idea over took plenty of selling.

"When the lines to the pump house were finished and the pumps overhauled, the works manager again surprised me. But this time he gave me the green light on the Quonset hut. I hadn't told him about my plan to keep my men after that project was finished, but that didn't worry me. I knew I could work the boys into different jobs because business was improving. That bridge could be crossed when and if I ever came to it.

"My pipe welders were happy about staying on the payroll. I told them to take it easy and do a first-class job. They turned to, bending and welding that old piping into framework—happy as a bunch of seamen going ashore after a long voyage. But the second day on that job the union delegate showed up.

" 'What in hell are those pipe welders doing putting up a Quonset hut?' he demanded, getting pink around the gills.

"I gave him the lowdown and explained the trouble I had in selling the boss on keeping the welders. I steered him clear on how I expected to keep them on the payroll for good after that hut was finished—if I could convince the boss they were needed.

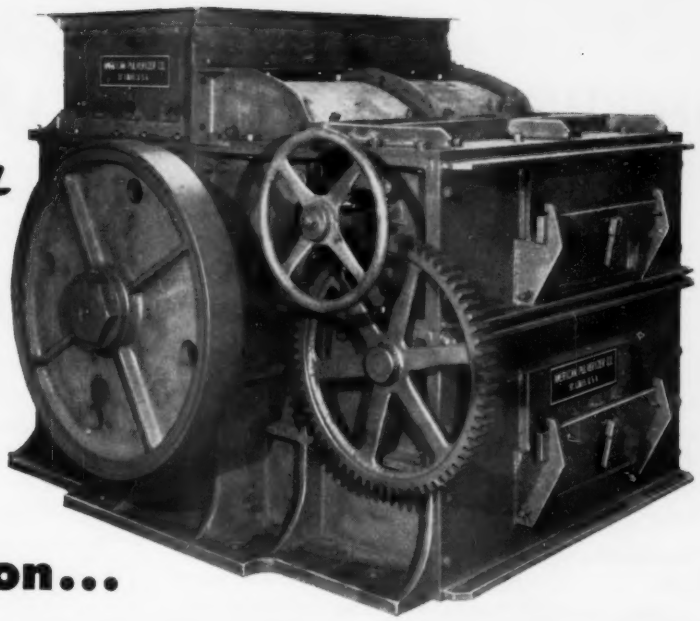
" 'You sure don't know our regulation', he argued. 'If you're going to put up that shop, you gotta have structural welders. These guys are pipe welders and they're not gonna do this job while I'm delegate.'

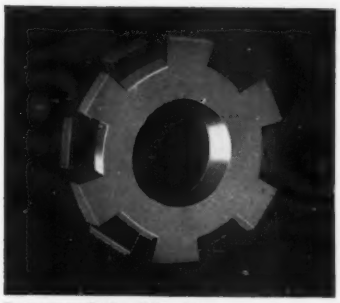
"I tried to talk sense—but it was no use. Either I'd get structural welders or my shop wouldn't be built. Fact that I was helping my welders by talking the boss into letting them do this job didn't dent the delegate's thick hull.

" 'OK', I finally agreed. 'I'll do this job by complying with the union requirements. For your information, *jun-*

(*Continued on page* 214)

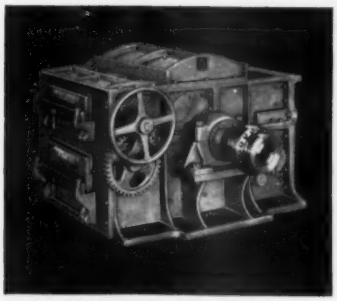
5 reasons why *American Crushers* can reduce coal for less than per ton...





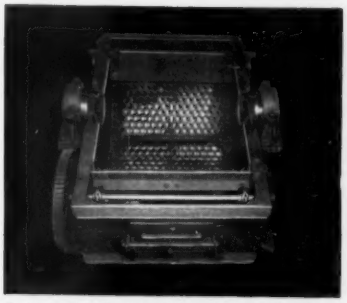
1 Patented Shredder Ring

American-originated feature that splits coal instead of smashing it—for uniform sizing, minimum fines. Result: Americans run at slow speeds, with savings in power and maintenance. No cams, shear pins, toggles.



2 Heavy-Ribbed Steel Frame

Bearing pedestals are cast integrally with lower side frames. Sectional design for easy dismantling . . . abutting joints accurately machined and bolted together for dust-tight fit.

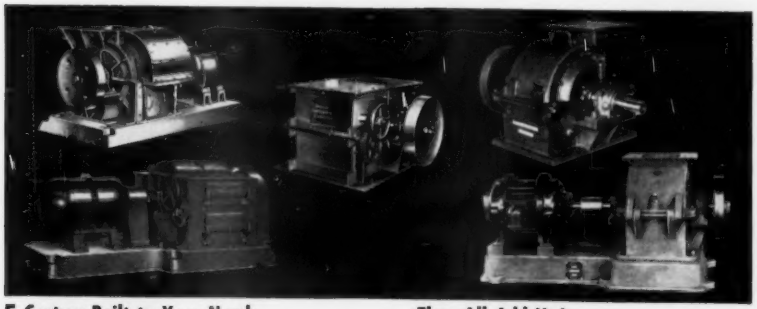


3 Completely Lined Crushing Chamber

Heavy, renewable liners . . . sectional for easy plate-at-a-time replacement . . . engineered to offer life-time protection to the frame.

4 Complete Accessibility to Adjustment and Parts

All adjustments external—even with crusher in motion. Rotor easily reached by removing top section. Rings readily reversed or replaced. Liners quickly reached, too, for periodical inspection.



5 Custom-Built to Your Needs

American has developed many crusher types, each in a number of sizes. Custom-designed with the proper crushing elements, grate bars or screen plates to produce the desired product in the quantities required.

They All Add Up!

Whenever you figure cost per ton, the best answers come from American. By actual survey, American Crushers, in use an average of ten years, show a parts replacement cost of only 1/10th of 1¢ per ton of coal crushed!

American PULVERIZER COMPANY

Coal Crushers up to 800 Tons Per Hour • Laboratory Crushers up to 2,000 Lbs. Per Hour

Originators and Manufacturers of Ring Crushers and Pulverizers

1349 MACKLIND AVE. • SAINT LOUIS 10, MO.

JENKINS PRACTICAL PIPING LAYOUTS

73

How to plan

PIPING FOR ACID LIQUOR PREPARATION IN THE SULFITE PULPING PROCESS

Several chemical processes are used in the pulping of wood used for paper manufacturing. They differ mainly in the chemical solution, or "liquor," that is used in the digester. This diagram shows the system required to produce the acid liquor used in the sulfite pulping process.

The mechanical preparation of the wood, prior to pulping, is essentially the same for all processes. Logs are sawed to suitable lengths for convenient handling, and bark is removed. The wood is then converted to chips, which are stored in bins.

Chemical processing begins when the chips are conveyed to the digester for cooking, in whatever chemical solution is dictated by the process used. After cooking is completed, the pulp is washed and screened, sometimes bleached and dried, to proceed eventually to the paper making process.

The sulfite pulping process calls for a digester solution that is strongly acid. It is prepared by burning sulfur or pyrites to form sulfur dioxide, which is passed through absorption towers containing limestone and water. This produces an acid liquor consisting mainly of calcium bisulfite and sulfurous acid. The chips are cooked with this acid liquor at approximately 300°F, by steam admitted as indicated in the diagram.

Pressure is reduced by opening the digester relief valve when cooking is completed. The hot gases pass through the coils in the acid storage tank to preheat the liquor, then back to the reclaim tower where they go into solution. Next, the liquor and pulp are forced into the blow pit by the pressure remaining in the digester. The liquor is drained off and sent to waste, or is processed for by-products. Water, free of impurities which might contaminate the pulp, is then admitted to wash the pulp thoroughly. After this washing, the pulp passes onto screens and eventually to the paper making process as stated above in the third paragraph.

Valves controlling the dry sulfur dioxide gas (prior to passing through an absorption tower) are iron body bronze mounted. Valves specified for the wet sulfur dioxide gas (after passing through an absorption tower) are stainless steel, because of the corrosive nature of the acid bearing gas. Valves in the liquor lines are Stainless Steel, Type 316, due to the corrosive combination of calcium bisulfite and sulfurous acid. Valves for water and steam lines are all bronze, with the exception of the check valves marked "S" and "Y", which are stainless steel due to the possibility of acid liquor or gas backing up. Valves on steam lines handling steam of moderately high pressure should be cast steel.

Consultation with accredited piping engineers and contractors is recommended when planning any major piping installation.

To save time, to simplify planning, to get all the advantages of Jenkins specialized valve engineering experience, select all the valves you need from the complete Jenkins line. It's your best assurance of *lowest cost in the long run.* Jenkins Bros., 100 Park Ave., New York 17. Sold through leading Industrial Distributors everywhere.

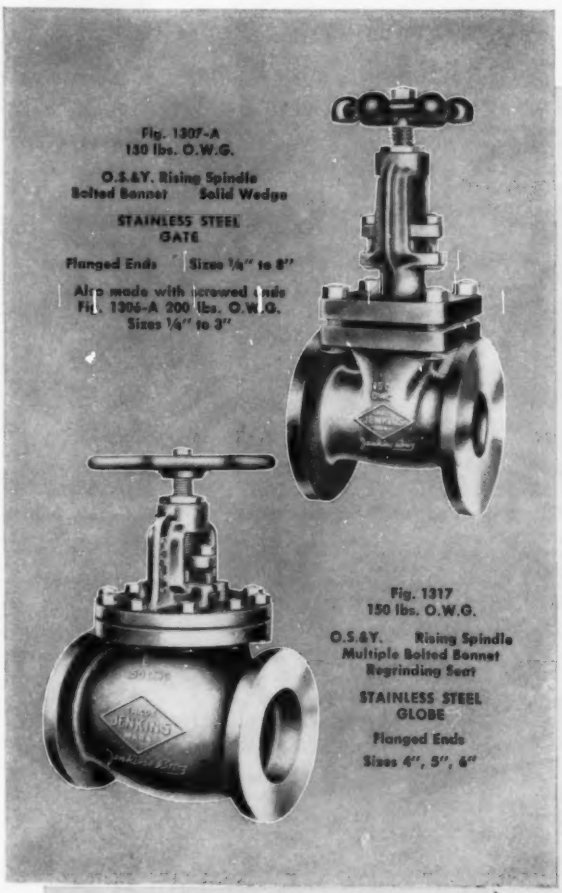
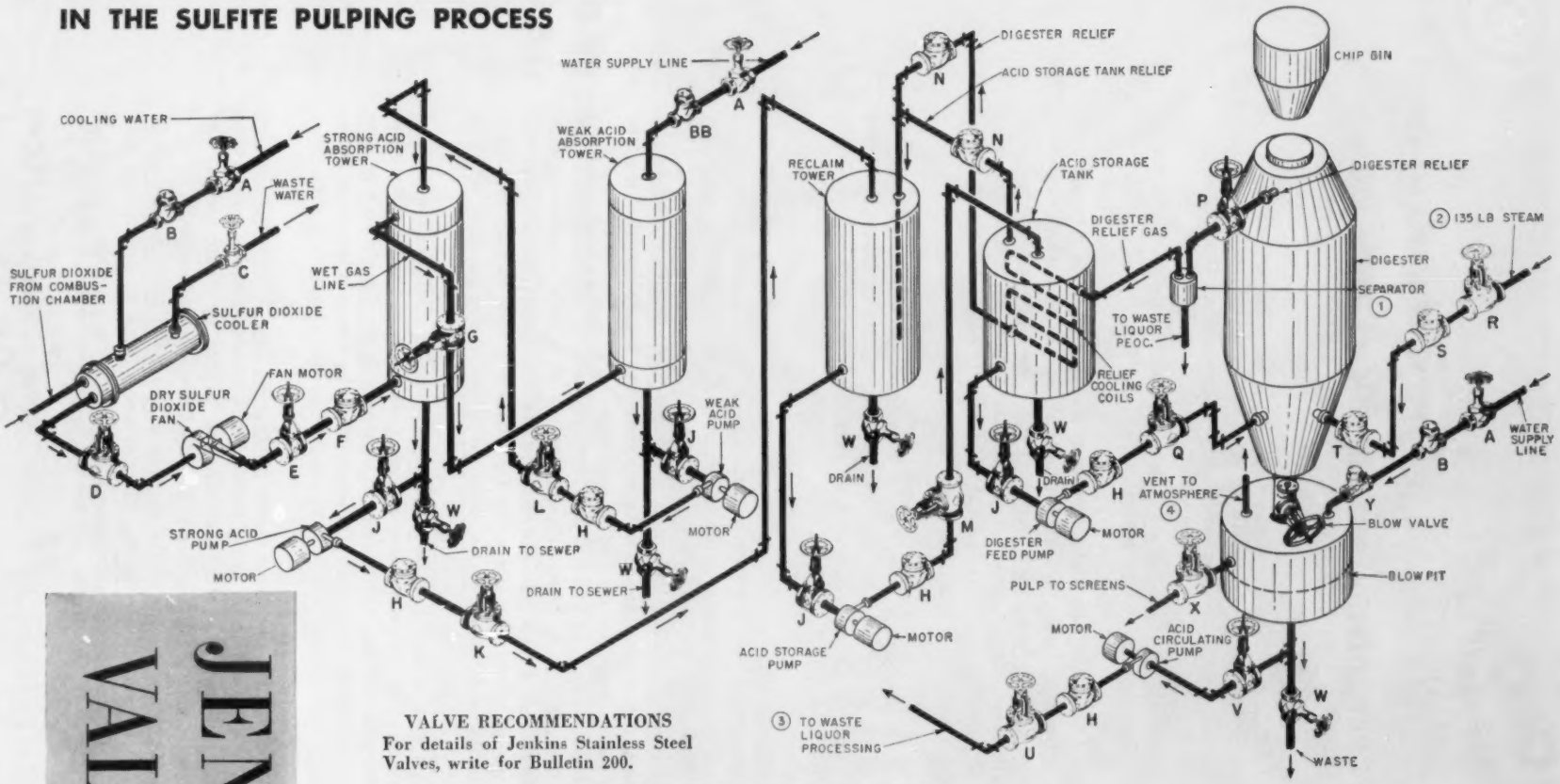


Diagram by Huxley Madeheim, Consulting Engineer
Copyright, 1954 — Jenkins Bros.

PIPING FOR ACID LIQUOR PREPARATION IN THE SULFITE PULPING PROCESS



VALVE RECOMMENDATIONS
For details of Jenkins Stainless Steel Valves, write for Bulletin 200.

CODE	QUAN.	JENKINS VALVE	SERVICE
A	3	Fig. 106-A, Bronze Globe	Water Supply Control
B	2	Fig. 352, Bronze Swing Check	Water line secondary check
BB	1	Fig. 1328, Stainless Steel Swing Check	Water line check
C	1	Fig. 47-U, Bronze Gate	Cooler water shutoff
D	1	Fig. 613, I.B.B.M. Globe	Sulfur dioxide fan control
E	1	Fig. 651-A, I.B.B.M. Gate	Gas shutoff
F	1	Fig. 1331, Stainless Steel Swing Check	Prevent strong acid backflow to SO_2 fan
G	1	Fig. 1307-A, Stainless Steel Gate	Gas shutoff
H	5	Fig. 1331, Stainless Steel Swing Check	Prevent backflow to pump
J	4	Fig. 1307-A, Stainless Steel Gate	Pump suction shutoff
K	1	Fig. 1317, Stainless Steel Globe	Strong acid pump discharge control
L	1	Fig. 1317, Stainless Steel Globe	Weak acid pump discharge control
M	1	Fig. 1317, Stainless Steel Globe	Acid storage Pump discharge control

CODE	QUAN.	JENKINS VALVE	SERVICE
N	2	Fig. 1331, Stainless Steel Swing Check	Prevent gas backflow
P	1	Fig. 1307-A, Stainless Steel Gate	Digester relief control
Q	1	Fig. 1317, Stainless Steel Globe	Digester feed pump discharge control
R	1	Fig. 1040, Cast Steel Globe	Steam control valve
S	1	Fig. 1025, Cast Steel Swing Check	Steam line secondary check
T	1	Fig. 1331, Stainless Steel Swing Check	Prevent acid backflow
U	1	Fig. 1317, Stainless Steel Globe	Acid circulation pump discharge control
V	1	Fig. 1307-A, Stainless Steel Gate	Circulating pump shutoff
W	5	Fig. 1308, Stainless Steel Globe	Drain control
X	1	Fig. 1317, Stainless Steel Globe	Pulp discharge control
Y	1	Fig. 1328, Stainless Steel Swing Check	Prevent acid backflow

JENKINS VALVES
LOOK FOR THE JENKINS DIAMOND
SINCE 1864
TRADE JENKINS MARK
Jenkins Bros

Speaking of power

personal slants on doings of interest to power men—some significant, some just odd

Controls again? Could be, if the Indo-China situation brings on a big expansion in defense programs. Authority now exists to allocate materials—it's being used today for titanium, could be extended readily to cover other items that might get to be in short supply.

Inventories could be regulated also, but before wages and prices could be fixed, Congress would have to take action.

Nuclear research reactor at Penn State is among the first of what may prove to be quite a number of university-sponsored units. Expected to operate early next year, this reactor will be of the "swimming-pool" or water-shielded type. Its Leeds & Northrup packaged control setup, comprising cubicle-mounted electronic recorders and operating mechanisms, will show reactor power level and rate of change, position the control rods, and record the log count rate.

Running a power plant is simple, Merle Newkirk used to delight in saying. When anyone asked how it was done, the genial former power boss at Dow Chemical's big Midland, Mich. plant made the smiling reply, "All we do is boil water and squeeze the juice out of it."

Barge shipment of natural gas doesn't sound so odd when you figure on chilling it way down first. Right now a Chicago businessman is building eight barges to carry gas from Louisiana wells up the Mississippi. Gas will be compressed and cooled to - 285 F at the well head, and shipped as a liquid.

Proponents of the scheme claim it's cheaper than pipeline transportation. And, they point out, it promises to make it possible to handle output of isolated wells, bring gas to areas not reached by pipelines.

Two recent news items tickled my fancy, though they've no visible connection with power. One concerns a new type of lock with built-in sound effects to confuse the light-fingered gentry who listen for the tumbler clicks as they sensitively manipulate the knob. Seems sort of unfair to people who've patiently acquired a rather specialized and delicate skill.

The other item reports that Minneapolis-Honeywell's Philadelphia management is sending clerks to penmanship school in an effort to eliminate mistakes caused by illegible writing, particularly of numbers. Maybe there's an idea here for us engineers, whose handwriting is often ruined by the twin habits of lettering and using a typewriter.

Research on power problems continues apace. Bituminous Coal Research is looking into spray-type dust collectors to (1) reduce stack emission during sootblowing, (2) minimize corrosion and stack deterioration caused by water sprays, and (3) gather data to help plants operate within legal stack-emission limits.

GE scientists are working on the mystery of why metal surfaces of contacts sometimes fail to conduct electricity. They're using loops of minute fine platinum wire to probe surface films that may hold the answer.

Lou Lowley

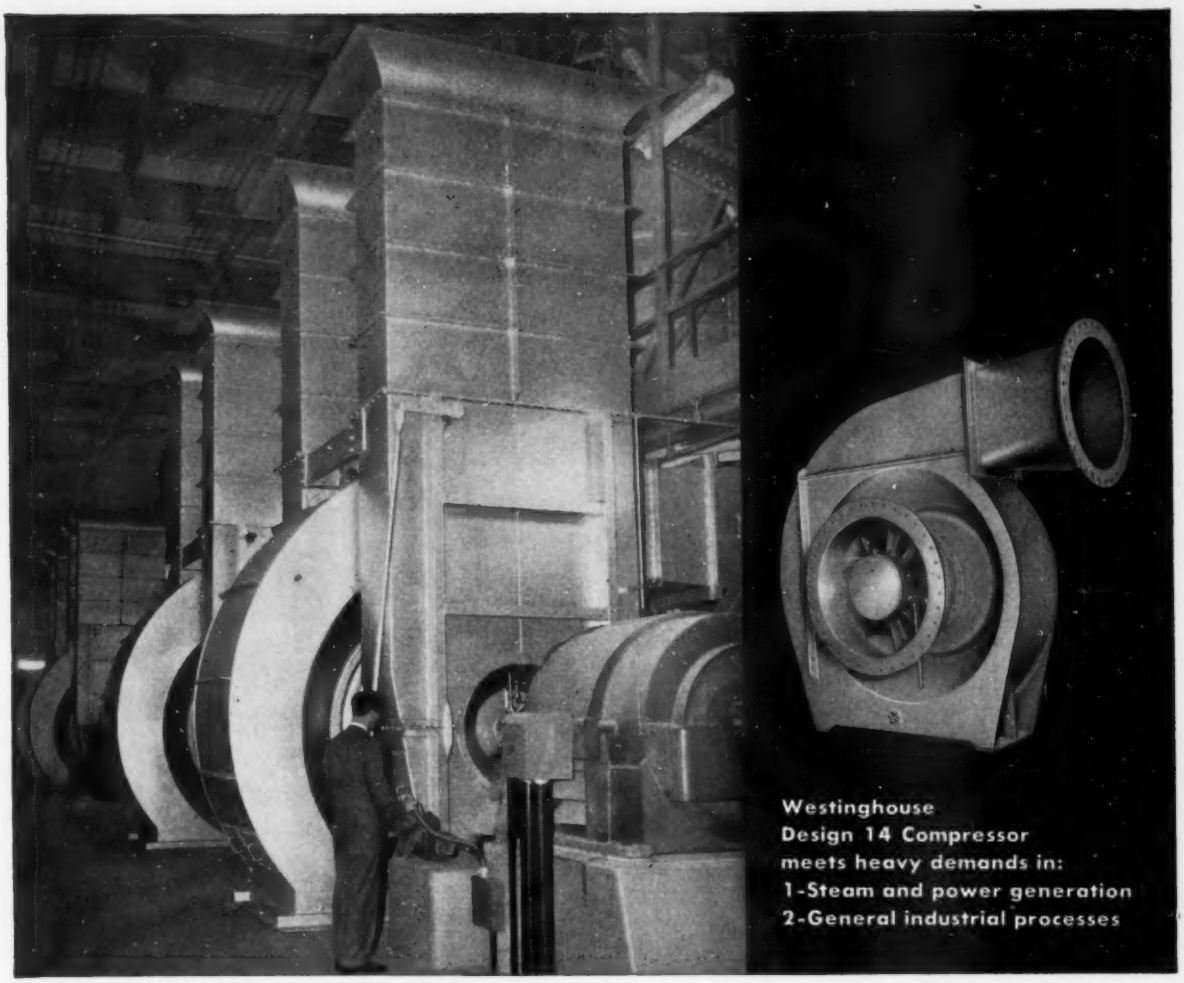


Photo courtesy Ohio Edison Co. at Niles Power Plant, Niles, O.

4 Westinghouse High-Pressure Compressors Supply Air to Cyclone Furnaces in New Ohio Edison Plant

Four Westinghouse Design 14 high-pressure Compressors supply forced draft to the two Cyclone furnace boilers at the new Niles Power Plant of Ohio Edison Company. Capacity of each boiler: 885,000 pounds of steam per hour. Working two to a boiler, each Design 14 Compressor delivers 135,000 cfm at 70 inches of water while operating at 1775 rpm. Westinghouse vane control regulates air volumes as required.

Design 14 Compressors are rugged, efficient, responsive to changing demand . . . maintain output while cutting costs. They provide variable or constant air volumes at constant pressures for many important industrial processes. Such as: atomic pile cooling, catalyst and scavenging blowing, supercharging diesel or gas engines, ore flotation. For these and other uses, Design 14 Compressors are available in single-width or double-width arrangements, with capacities up to 200,000 cfm and pressures up to 110 inches water gauge.

QUIET OPERATION—Casing proportions and streamlined wheel passages make Westinghouse Design 14 Compressors *inherently quiet*. Accessory sound-absorbing trunks of proved design reduce noise level even further.

A Sturtevant specialist located in your area will assist you now in selecting Westinghouse Design 14 Compressors for your specific requirements. Call him. Or write: Westinghouse Electric Corporation, Sturtevant Division, Hyde Park, Boston 36, Mass.

WESTINGHOUSE AIR HANDLING

YOU CAN BE SURE...IF IT'S Westinghouse

J-80403A

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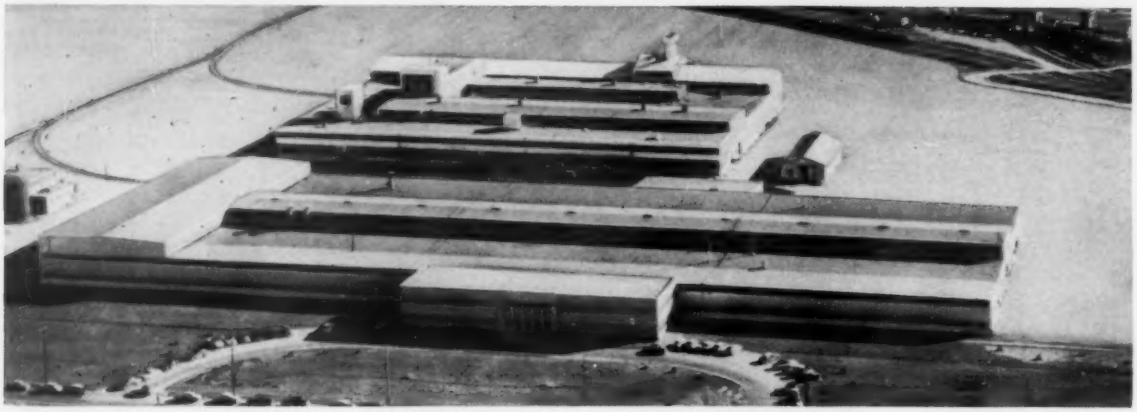


AERIAL VIEW of new Fairbanks, Morse & Co pump works at Kansas City, Kan. Occupying a 38.5-acre site, the plant features the latest in modern manufacturing facilities and tools. Manufacturing area covers 180,000 sq ft, foundry 147,600

ASSEMBLY LINE rounds the corner and stretches away toward the testing floor. Many varieties of pumps are assembled here

Fairbanks, Morse & Co Opens New Pump Works

► To HELP MEET the nation's increased demand for water by better and more efficient pumping, Fairbanks, Morse & Co has built a new pump manufacturing plant at Kansas City, Kan. Geared to an annual output of enough pumps to move 35 billion gallons of water or other fluids per day, the new plant boasts one of the nation's most modern foundries and a manufacturing area of 180,000 sq ft.

Pumps up to 16-in. diameter discharge and engines from 2 to 30 hp will be built at this plant. While geared for multiple production, the precision and variety required prevent mass production in the same sense as the auto industry.

The 38.5-acre site was selected because of the central location of Kansas City, Kan. When the works is in full operation, an estimated 900 persons will be employed. This includes 425 in manufacturing, 200 in the foundry, 150 in offices, 75 in maintenance and 50 in administrative work.

(*Continued on page* 234)

STEEL PINS, on which insulation is impaled, hold it firmly to side of sphere

Insulating the World's Largest "Thermos Bottle"

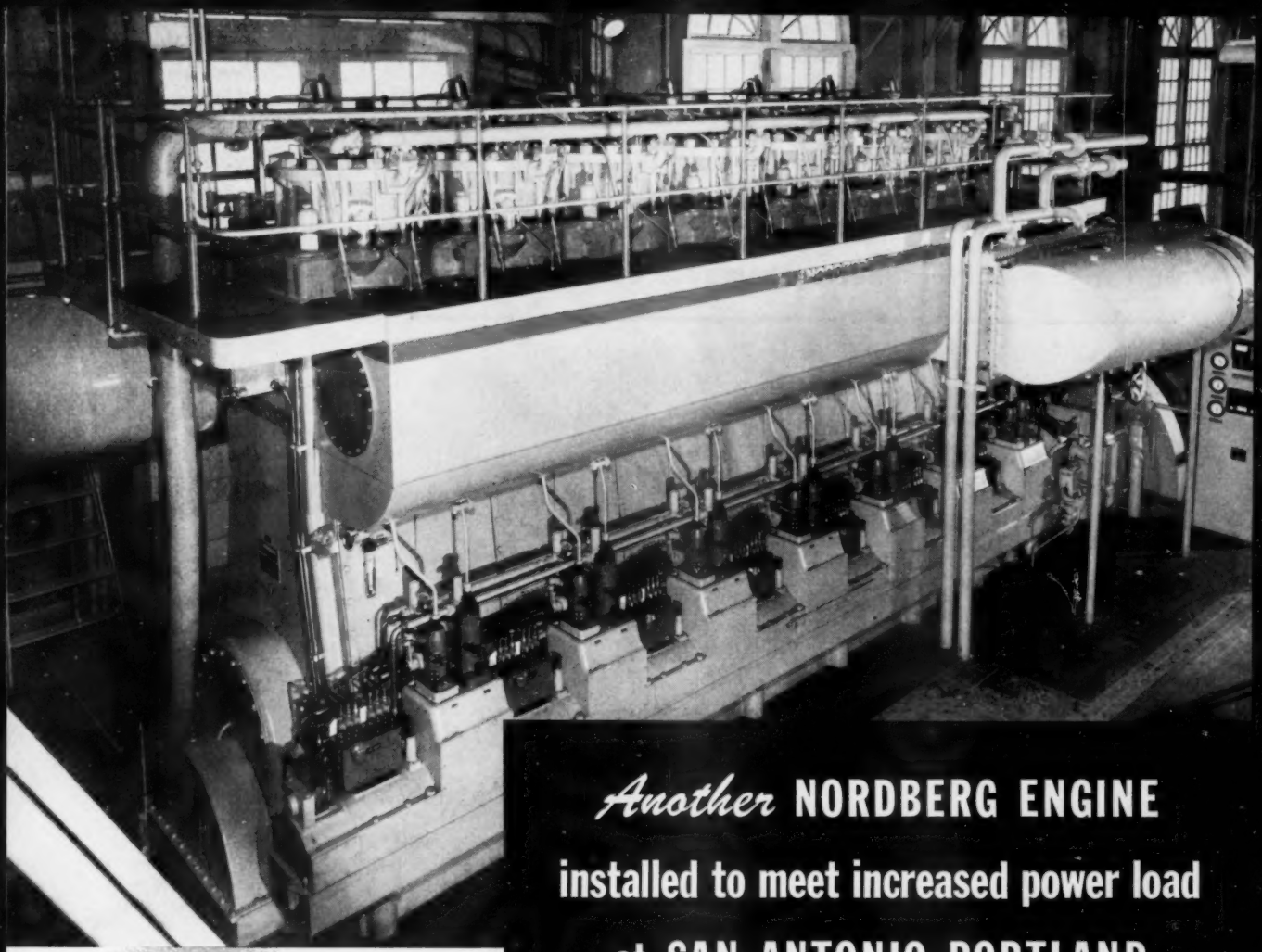
► INSULATING the huge sphere for use by the AEC and General Electric Co for testing an atomic submarine engine, presented some unique problems. The sphere, 26 times larger than any other previously built, is 225 ft in diameter and has a content of 5.5 million cubic feet. It is designed to minimize escape of fissionable materials during tests of the atomic engine.

More than 138,000 sq ft of *Foamglas*, a cellular glass material developed by

(*Continued on page* 234)

For coming events see page 236

WORLD'S LARGEST "thermos" is insulated with 138,000 sq ft of cellular glass



Another NORDBERG ENGINE installed to meet increased power load at SAN ANTONIO PORTLAND CEMENT COMPANY

SAN ANTONIO PORTLAND CEMENT COMPANY, one of the pioneer producers in the cement industry, has an enviable reputation for its efficient operation and quality product. Knowing that low cost power means lower cost cement production, this progressive company has long depended upon Diesel generating units as the main source of processing power for their Cementville, Texas plant.

The first Nordberg engine, a 3600 hp, 2500 kw gas burning unit, was installed in the San Antonio plant in 1948. In 1953, when additional capacity was required, another large Nordberg gas burning engine was installed—a 3010 hp, 2100 kw unit.

It is interesting to note that while this plant has a total of eight Diesel generating units, the two Nordberg engines represent over half of the total installed horsepower and carry 75% of the total load.

This is one more example of the way Nordberg Engines are being used to provide dependable, low cost industrial power. Next time you have a power problem think of Nordberg . . . builders of America's largest line of heavy duty engines, from 10 to over 10,000 horsepower.

NORDBERG MFG. CO., Milwaukee, Wisconsin

NORDBERG

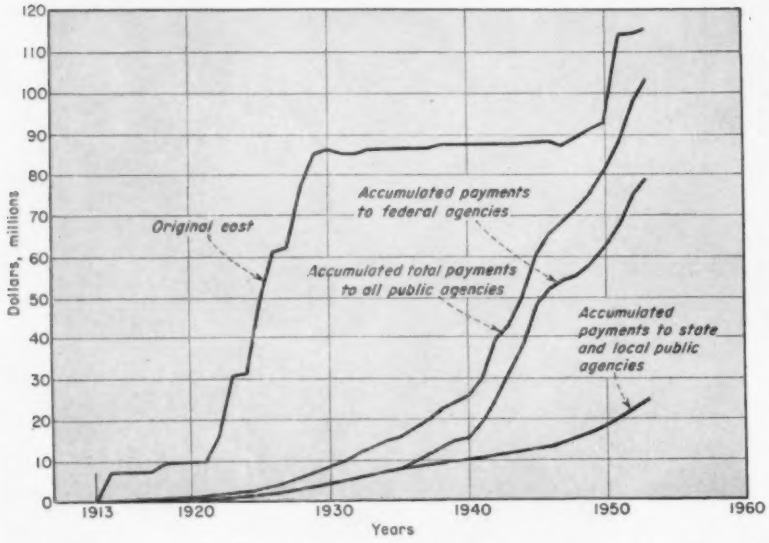
DIESEL • DUAFUEL® AND SPARK-FIRED GAS ENGINES

P454

TECHNICAL BRIEFS

Latest engineering developments for busy power men

8 digests for you on:
HYDRO DEVELOPMENT
BOILERS
STEAM PLANTS
FUELS


Dollars, millions
Years
Original cost
Accumulated payments to federal agencies
Accumulated total payments to all public agencies
Accumulated payments to state and local public agencies

INVESTMENT in hydroelectric developments of Southern California Edison Co and accumulated payments, because of the projects, to all local and federal agencies

Public-utility company versus government hydro development

Big Creek-San Joaquin Project and Public Interest. *By W L Chadwick, vice-president of engineering and construction, Southern California Edison Co, Los Angeles, Calif.*

Four purposes: irrigation, hydroelectric power, flood control and public recreation were joined in one project more than 40 yrs ago in construction of the Big Creek-San Joaquin hydroelectric development of Southern California Edison Co.

Today, total capacity of the six Edison hydroelectric plants is 530,000 kw. In an average water year they produce about 2.8 billion kwh, compared to production at Hoover Dam of about 5.4 billion kwh. Average energy production from the South Fork and Big Creek water through the main power plant chain is 4625 kwh per acre-foot, which makes it the hardest working water on the earth.

Big Creek-San Joaquin project has many interesting engineering features. It also affords a measure of revenue and other benefits, over and above light and power, which the public receives without expense. Total original cost of the development excluding transmission lines to Los Angeles, is $115,663,000—all of which is borne by power. There are no credits for irrigation, flood control, fish and wildlife or other benefits. This one project, although built entirely at private cost, has produced the following advantages for the public:

1. Irrigation water amounting to 70,000 acre feet in an average water year, and upon completion of construction in progress 120,000 acre-feet of new water in a drought year. This water is supplied to some of the nation's most productive land.

2. Flood control storage of about 200,000 acre-feet.

3. Four, and in another year, five large fish-bearing lakes.

4. Access to playgrounds of more than 1000 sq miles.

5. Power totaling 63,174,000,000 kwh at prices which have been continuously regulated by governmental agencies.

6. Revenue to date aggregates $103,590,000 and a continuing annual revenue of more than $5,000,000.

Chart, *left*, shows the accumulated investment in the project to the present date, and separately shows accumulated payments because of the project, to all local and federal public agencies. Local payments are for city, county, school-district and state taxes to the end of 1953. These payments have aggregated $24,715,000 or 22% of original cost of the development. Payments to federal agencies include those for use of public lands under the Federal Power Act and other legislation, a proportionate share of excise taxes on sale of electricity, and a share of federal income taxes based on proportion of kwh generated by the project to the total for the system.

Aggregate of these federal payments over the history of the project is $78,875,000 or 68% of its original cost. Combined payments to public agencies total about $103,590,000 or 90% of original cost of the project. At the rate in effect during 1946 through 1953 the annual average payment was $5,409,000, almost equaling the gross annual revenue currently produced by Hoover Dam project. This rate of payment, if continued, would pay to public agencies the entire cost of the project every 21 years.

On basis of the usual measure of merit of an investment, the public would have infinite investment yield with $115,663,000 income each 21 years, with no capital paid in. Stated in another way, during 1953 total payments to the public alone amounted to $23.45 per kwh year. System-wide, total payments to the public during 1953 aggregated almost 4 mills per kwh sold.

Frequently we hear appeals to the voter allegedly giving away a public inheritance to private interest for private profit. From the foregoing facts, can it be shown that anyone profits more from private hydroelectric power developments under the Federal Power Act than the public itself? *APC paper*

(*Continued on page* 156)

Can I use this sheet packing on hot oil lines, too?
Johns-Manville
Sure J-M Service Sheet is equally good for oil, steam and gas lines!

Your J-M Packings Distributor can tell you why this quality sheet packing has maintained such an excellent reputation for over 35 years

Where it's used: Every industrial plant can use J-M Service Sheet Packing to advantage. It's the favorite packing of thousands of plant engineers and maintenance men. Both versatile and dependable, Service Sheet makes a tight, long-lasting seal against superheated steam, air, gas, water, hot oil and ammonia, as well as many acids and chemicals.

What its advantages are: J-M Service Sheet is a quality packing, made of selected long-fibre asbestos bonded with heat-resisting compounds. It is graphited on one side to permit breaking a joint without destroying the gasket. The ungraphited side is ruled into one-inch squares to speed cutting and reduce waste. And . . . you can order it in large economical quantities because J-M Service Sheet will not dry out in stock!

How it is furnished: Service Sheet is supplied in sheets 54″ x 63″, 36″ x 126″, 36″ x 63″, and 54″ x 126″ sheets in thicknesses of 1/64″ to ¼″ and 108″ x 126″ sheets in thicknesses of 1/32″ to ¼″. It is also furnished as cut gaskets in standard and special shapes. See the J-M catalog for further details.

Your J-M Packings Distributor carries complete stocks of J-M Service Sheet and other quality Johns-Manville Packings. He can help you choose the right packing for your application. Write him for complete information and copy of folder PK-19A, "Thousands of Plants Rate It Tops." Or address Johns-Manville, Box 60, New York 16, N. Y. In Canada, 199 Bay Street, Toronto 1, Ontario.

JOHNS-MANVILLE JM PRODUCTS

Johns-Manville PACKINGS & GASKETS

More TECHNICAL BRIEFS

Begins on page 154

HYDRO *continued*

Development of Hydroelectric Power Resources Under Provision of the Federal Power Act. *By Jerome K Kuykendall, chairman, Federal Power Commission, Washington, D. C.*

The Federal Power Commission staff estimates aggregate capacity of hydroelectric power sites in the United States, developed and undeveloped, to be nearly 109 million kw, or slightly more than all generating capacity—steam, hydro and internal-combustion engines—now in operation in central stations.

Presently, about 23 million kw of generating capacity, roughly 21% of total potential capacity, has been installed in power plants throughout the country. Half of this development has been done by privately financed projects, half in public projects.

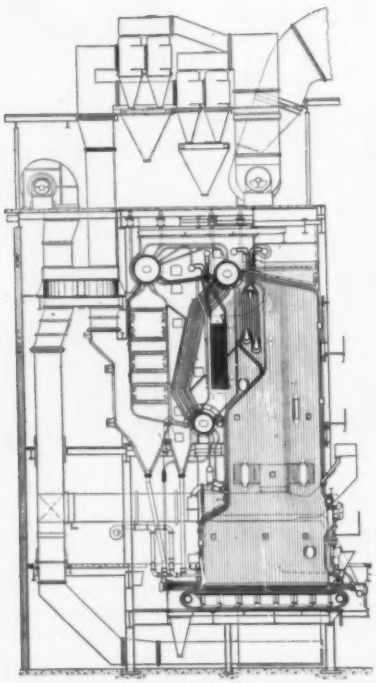
Importance of developing this source of literally inexhaustible energy is easily demonstrated in terms of conservation of fuel used for the production of electric power. For example, annual output of constructed hydroelectric plants is equivalent to usable energy recoverable from over 64 million tons of coal, more than 11-billion gallons of oil, or about 1.5-trillion cu ft of gas. These savings represent 11 to 25% of 1950 production of these fuels, and they will continue to increase as hydroelectric resources are developed.

Hydro power development by non-federal agencies on government lands and streams was slow prior to enactment of the Federal Water Power Act of 1920. By July 1, 1921 the commission received 229 applications for projects representing 15,026,000 hp of installed capacity. By June 30, 1923 it had increased to 21,500,000 hp—more than double U.S. hydro to that date.

Since formation of the commission in 1920 through 1953, applications for preliminary permits or licenses have been filed in connection with 2,148 projects for about 6,784,000 kw of initial capacity and an ultimate installation totaling about 10,000,000 kw. Of these licenses, 219 were for major power projects of more than 100 hp capacity. Projects under license account for about 53% of the total hydroelectric capacity in the U.S. which is not owned by the federal government. Pending before the commission at the end of 1953 were applications for preliminary permits, licenses, and amendments totaling about 10,838,000 kw of new hydroelectric capacity, including both public and private developments.

Indicative of the recent up-surge in activity relative to non-federal hydroelectric developments are figures for the fiscal year ending June 30, 1953. During this period applications were received for installations aggregating 4,221,000 kw of net generating capacity. During the last six months of 1953 applications were received for a net total of 4,450,000 kw. Accordingly, on the basis of the records, the Federal Power Act has provided a climate favorable to development of hydroelectric power resources and opportunity for participation by all interests, federal and non-federal, public and private. *APC paper.*

Directions for ordering papers are given on page 230



Boilers

Some economic factors influencing industrial boiler development. *By Carl F Miller, Combustion Engineering, Inc.*

Most of the factors influencing industrial boiler development are the same as those affecting general economic changes and include principally the cost of labor, material and capital. Of particular importance are the costs of different fuels and their trends in quality and availability. It is during the last ten years that the effect of these factors on boiler design has been most pronounced.

As wage rates have risen, boiler plant management has approached the problem of keeping these costs in line by selecting equipment that can be operated and maintained with the smallest crew. Number of units has been minimized by using larger size boilers. Since shop efficiency is higher than in the field, and labor costs are lower, manufacturers now perform as many operations as possible in the shop. Automatic controls have also helped reduce labor costs.

To keep up with the rise in steel costs, which have gone from $2.19 to $4.10 per ton between 1943 and 1953, greater attention has been given to the design of furnace and convection surfaces to improve absorption efficiency of the heating surface. This approach has produced many changes in the general arrangement of the boiler, fans and heat-recovery units to reduce steel needs.

Rising fuel costs have affected boiler development in many ways, including the arrangement of boiler surface, the increased use of heat-recovery equipment, higher pressure and temperatures, and the design of auxiliary equipment such as air heaters and economizers. To point up the effects of fuel costs on boiler design, the paper illustrates a number of typical units built to overcome specific problems in a given plant or area. Unit, *left*, burns organic residue, coal and gas. *APC paper.*

Steam plants

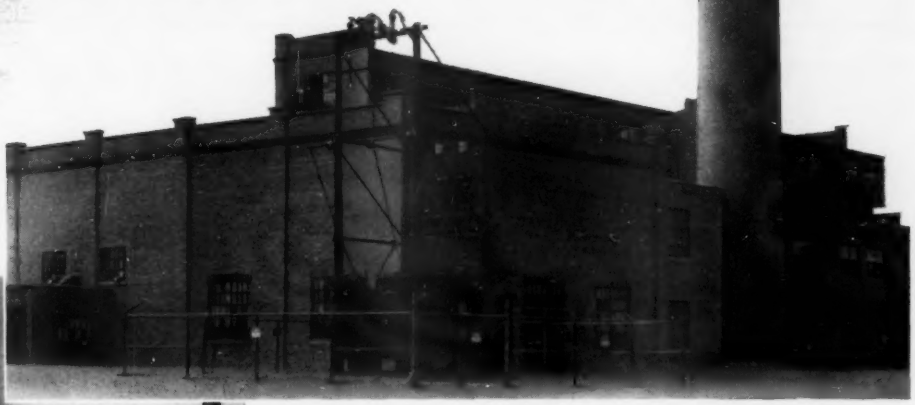
Application of equipment in outdoor steam electric generating stations. *By W D Marsh and A G Mellor, Electric Utility Engrg Section, General Electric*

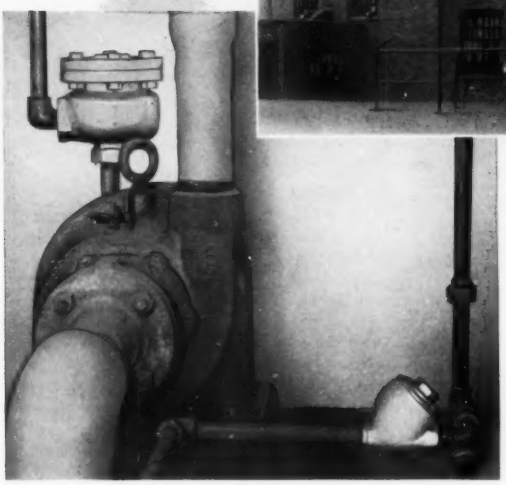
There is wide divergence of opinion among station designers as to the extent to which outdoor features should be adopted. Stations being built today range from those in which all equipment except large transformers and high-voltage switchgear are completely enclosed to those in which all major equipment, except controls, is outdoors.

Factors favoring outdoor-type construction include savings in first cost, (reported as $3 to $8 per kw installed), possible reduction in station construction time, elimination of many ventilation problems and reduction of power needed for heating and ventilation, greater fire safety, and the preference

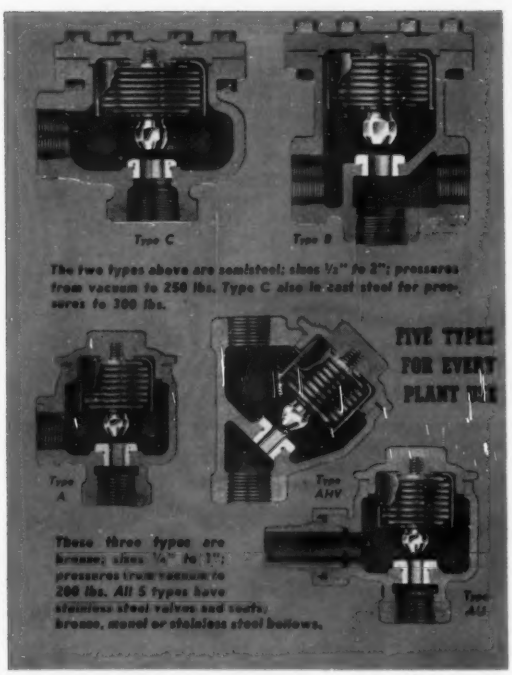
(*Continued on page* 224)

NICHOLSON TRAPS SELECTED FOR *Celanese* STEAM PLANT





Above, enlarged steam generating facilities of the Celanese Corporation of America plant at Hopewell, Va., now in an extensive expansion program. Specified were Nicholson Steam Traps, two of which are shown at left.


Type C
Type B
The two types above are semisteel; sizes ½" to 2"; pressures from vacuum to 250 lbs. Type C also in cast steel for pressures to 300 lbs.
FIVE TYPES FOR EVERY PLANT USE
Type A
Type AHV
Type AU
These three types are bronze; sizes ¼" to 1"; pressures from vacuum to 200 lbs. All 5 types have stainless steel valves and seats; bronze, monel or stainless steel bellows.

How to use modern equipment to bring the steam generating capacity of a boilerhouse up to the needs of an extensive plant expansion program was recently demonstrated by Celanese Corporation of America at its Hopewell, Va., textile plant.

Stoker equipment to fit present space, and auxiliary equipment of the most modern nature -- all were selected with a view to attaining maximum efficiency, and desired capacity with a margin of space for further expansion. Nicholson Steam Traps were installed in connection with a new piping system which features return of the condensate and reclamation of most of its heat.

A recent survey showed these Nicholson features to be reasons why an increasing number of leading plants are standardizing on Nicholson thermostatic traps: 2 to 6 times average drainage capacity; shorten heat-up time. Operate at lower temperature differential; fast action keeps equipment full of live steam. Maximum air-venting capacity. Types for every process, power and heat application.

Send for
CATALOG 953

A 32-page standard reference; contains installation diagrams and data for determining proper size of trap.

W. H. NICHOLSON & CO.

TRAPS · VALVES · FLOATS

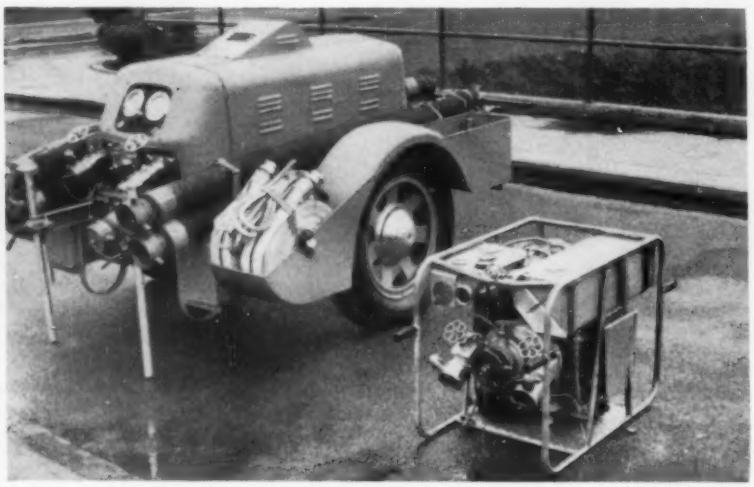
125 Oregon St., Wilkes-Barre, Pa.

Sales and Engineering Offices in 53 Principal Cities

PLANT EQUIPMENT NEWS

Your information center for new products designed to solve plant problems

Published monthly as a service to readers



Gas turbine powered pump delivers 600 gpm
Same capacity with 1/8 the weight

729 • The complete unit consists of a 600-gpm centrifugal pump close coupled to a 60-hp gas turbine mounted in a lightweight tubular frame. Included are a fuel tank and an instrument control panel. Photo shows the 215-lb hand-carried unit compared to a conventional 1754-lb gasoline-engine trailer-mounted unit of the same capacity. The gas-turbine powered pump may also be trailer mounted.

The single-shaft gas turbine turns at 46,000 rpm. The axial flow turbine has a rotor machined from a Nimonic forging with the blades integral with the disk. The single-stage centrifugal compressor of forged aluminum alloy has steel inlet guide vanes. The fuel system and governor is self-contained consisting of a starting control, accelerator control, maximum speed control, maximum temperature control and a fuel filter. The unit is started by hand crank in 15 seconds.

Rated fuel consumption is 1.46 lb per bhp per hr at capacity. Air flow of 1.35 lb per sec supports a turbine inlet temperature of 1112 F. A gear-type oil pump submerged in the oil sump in the base of the compressor housing feeds the lubrication system. A suction filter protects the pump and a discharge filter the lubrication system. Oil is cooled in the sump. A high-heat-release combustor uses either a spill-type burner or a variable-flow pressure-sensitive type burner.

The single-stage centrifugal pump has a capacity of 600 gpm at a total head of 231 ft with a 10-ft static lift. Reduction gearing drives the pump at 4500 rpm. The gear wheel is supported in a double-row conical roller bearing lubricated by pressurized oil from the turbine unit. This oil is injected into the bearings through a hollow shaft and returns via the gear casing to the oil sump.

The bearing housing and gear chamber are cooled by the water pumped. A plug in the pump casing allows taking off cooling water if needed.

Priming unit consists of an air ejector taking air from the compressed air receiver in the gas turbine. A single lever runs the ejector, which will lift water 24 ft at not less than 1 ft per sec with normal atmospheric pressure.

The starting hand crank connects by sprockets and chain to the oil-pump driving gear that operates the compressor shaft via the intermediate gear of the auxiliaries driving gear train. Ratio between compressor rotor and starting handle is 100:1. An electric generator runs in conjunction with starting mechanism to give the starting ignition in the combustor.

Instruments for the gas turbine include: oil-pressure gage, engine speed indicator, oil-temperature gage and fuel-control valve; for the pump: compound pressure gage (suction), discharge pressure gage, priming control and others.

The unit can run on gasoline or any distillate fuel such as white gas.

Sigmund Pumps Ltd, 41-02 Astoria Blvd, Long Island City, N. Y.

For more data on these items, use post cards p 167. Identify your request with item number.

Miniature electrical recorder

717 • Light-weight direct-writing recorder for voltage and current records is available in both ac and dc models. Applications include recording ampere-hour demand in power company surveys; checking reports of low voltage, over-loads, or unbalanced conditions; monitoring radio detectors when used with electronic amplifiers; recording current and duration in electroplating and metal refining; recording speed, as well as life tests of batteries of all types, lamps, etc.

For dc measurement, *Model 6401* is available in ranges from 1 ma to 5 amperes and from 100 millivolts to 300 volts. Higher ranges can be obtained through the use of accessory shunts or multipliers. For ac measurement, the rectifier type *Model 6402* is available in current ranges to 5 amperes, self-contained, and up to 300 volts, self-contained. Higher voltage ranges can be obtained through the use of external multipliers; higher current ranges with a *Model 604 Type 1* current transformer.

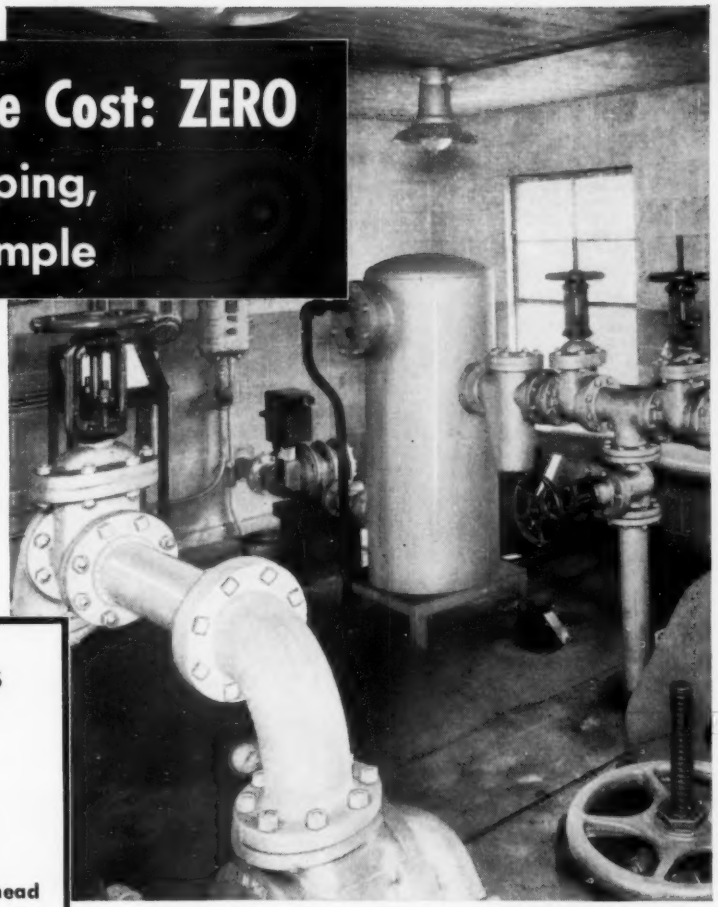
Weston Electrical Instrument Co, 614 Frelinghuysen Ave, Newark 5, N. J.

Variable-Speed Drive

763 • Countershaft type drive varies speed by changing its location between two fixed sheaves. Important feature of drive is said to be the spring loaded belt face which maintains correct belt tension in all speed positions. Standard V-belts are used in both the 4-in, ¾-hp and the 6-in, 1½-hp standard sizes. Bulletin 46.

Speed Selector Inc, 118-U Noble Court, Cleveland 13, Ohio

Valve Maintenance Cost: ZERO
...on fuel oil piping, for example



The Installation

At North End Yard, The Cincinnati Union Terminal Railroad, using Crane steel valves and fittings throughout diesel fuel receiving and filling system. Working pressure, 40 pounds.

Valve Service Ratings

SUITABILITY:
Doing the job as intended

FEATURES:
Exelloy seating

MAINTENANCE COST:
Zero

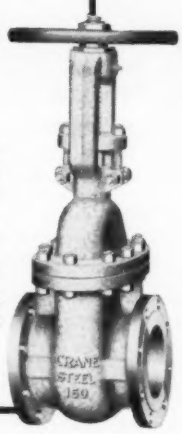
SERVICE LIFE:
Installed 1948—Shows long life ahead

OPERATING RESULTS:
Low-cost, trouble-free fueling

AVAILABILITY:
Crane catalog item—No. 47X

The Valve

150-Pound Steel Gate—with its exceptional performance assured by Crane quality design . . . by Crane pioneering skill in steel casting . . . and the high adaptability of Crane Exelloy trim for oil services. Sizes 2 to 24 in.; screwed, flanged, or welding ends. See your Crane Catalog, or ask your Crane Representative.



The Case History

Not until the terminal's engineers were convinced of its dependability and low-cost maintenance was any equipment bought for this project. Many similar systems were studied for the best means of assuring utmost economy of operation. The installation was made in 1948 . . . with welded piping where practical, using Crane materials exclusively—steel fittings, check valves, and No. 47X. 150-Pound steel gate valves.

More than 5 years later the terminal reports: Piping system operation entirely satisfactory; maintenance cost to date: zero. Further result: Crane valves have earned top consideration for proposed extension of system. The terminal knows the value of thrifty buying—quality always outweighs price-tag savings.

THE BETTER QUALITY...BIGGER VALUE LINE...IN BRASS, STEEL, IRON

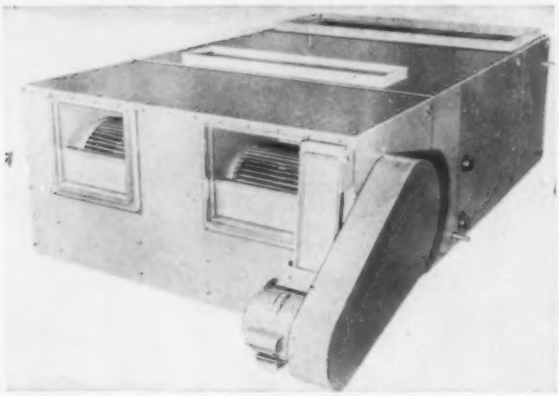
CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

More EQUIPMENT NEWS

Begins on page 158

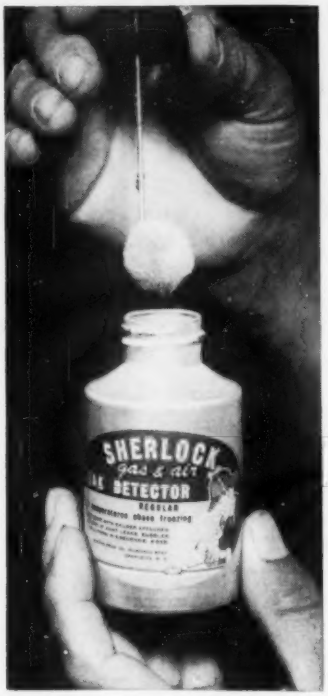


Heating-ventilating units handle up to 15,000 cfm

737 • A line of heating-ventilating units with capacities ranging from 1200 to 15,000 cfm can provide heating, ventilation, filtering, humidifying, or any combination of these functions. Models are available for installation on floors, ceilings, or walls. They feature any of ten different heating coils, both non-freeze and standard steam, and hot water coils. Low fan speeds assure lowest possible noise levels in the units. Fans are arranged for V-belt drive.

These *Herman-Nelson* units use long-life permanently lubricated ball bearings. Bulletin available.

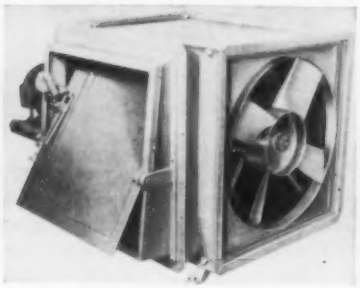
American Air Filter Co, Inc, Louisville 8, Ky.



Air or gas leak detector

750 • A leak detector is now available that can be used for piping, tubing, drums, or tanks and is quick and convenient to use. It is a chemical solution and comes complete with applicator. Its efficiency is much greater than that of soap solutions. Regular type is for temperatures above freezing. Low temperature type is also made. Begins action in 5 sec.

Winton Products Co, Dilworth Station, Charlotte, N. C.

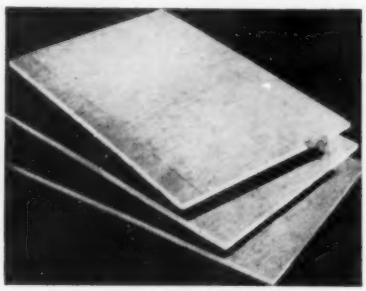


Draft inducer

733 • A draft inducer with interchangeable side panels permits easy adaptation of the unit to installation requirements for gas inlet and outlet. Mounting feet are movable, and spring-mounted variable-speed motor provides precise draft control.

Unit is compact, can be easily manipulated. Capacities to 100,000 lb per hr.

L J Wing Mfg Co, Linden, N. J.



Acoustical form board

748 • Incombustible *Fiberglas* acoustical form board serves as an attractive interior ceiling and as a thermal and acoustical insulation. It will not rot or decay.

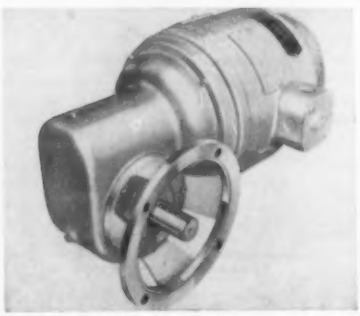
Light in weight, the board is easy to install by standard methods and is strong enough to carry wet gypsum.

Owens-Corning Fiberglas Corp, Toledo 1, Ohio

Sulphur dioxide detector

764 • New SO_2 gas detector is reportedly an exceptionally accurate yet easy-to-use instrument for determining concentrations of 0 to 50 ppm. User squeezes bulb three times for adequate air sample, then reads concentration on graduated scale. Reagent in tube turns from blue to white and length of decolorization is directly proportional to gas concentration. Further details available on request to manufacturer.

Mine Safety Appliances Co, Pittsburgh 8, Pa.



Worm reducer

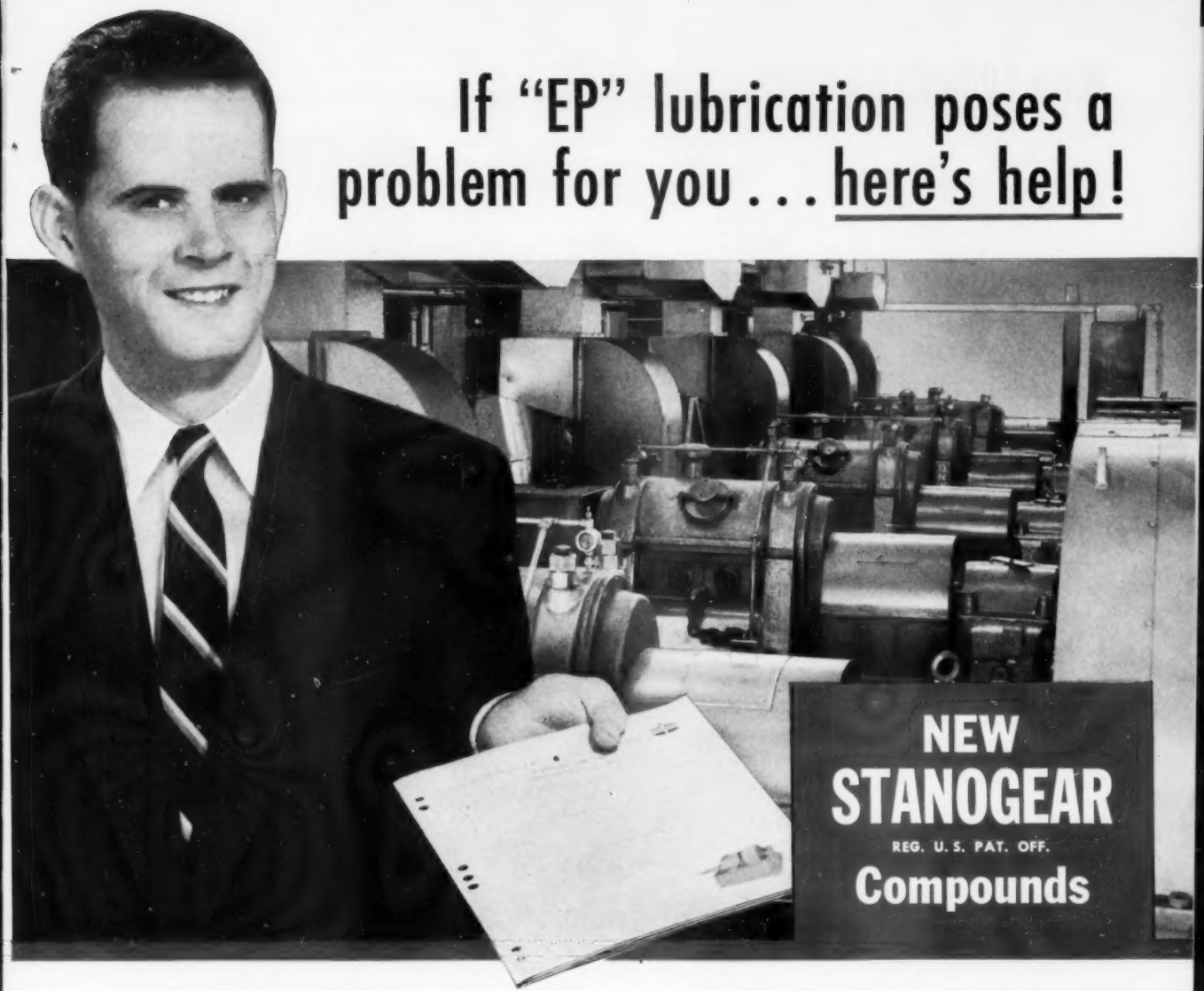
762 • Fluid-coupled worm type speed reducer is especially adapted to powering loads that require smooth, gradual acceleration. Unit is said to be unusually compact; can be mounted in 16 different positions to facilitate installation.

Available in sizes from 1/3 to 2 hp; speed reductions from 24 through 140 rpm.

Reuland Electric Co, Alhambra, Calif.

For more data on these items, use post cards p 167. Identify your request with item number.

If "EP" lubrication poses a problem for you . . . here's help!



Here's new technical letter on Stanogear Compounds—send for free copy today!

If you've been having lubricating problems with overloaded or shock-loaded gears on your equipment, New STANOGEAR Compounds—with 7 better EP lubricating features—are made just for you. New and improved STANOGEAR Compounds are recommended for industrial gear applications where the operating conditions of the gear unit demand an extreme pressure lubricant . . . their superiority has been proved in test after test and *on the job!*

New STANOGEAR Compounds work seven ways better to solve your EP problems: **1.** higher load-carrying capacity **2.** superior retention of load-carrying capacity **3.** freedom from objectionable deposits **4.** excellent storage stability **5.** good water separation **6.** anti-foaming **7.** increased versatility

Now Standard Oil has prepared a special technical letter to give the complete story on STANOGEAR Compounds and EP lubrication. For your copy of this factual, informative bulletin, call your nearest Standard Oil office. The Standard Oil lubrication specialist there can answer your questions and send you a copy of the EP story, without obligation. Or write to: Standard Oil Company (Indiana), 910 South Michigan Avenue, Chicago 80, Illinois.

STANDARD OIL COMPANY

STANDARD (Indiana)

More EQUIPMENT NEWS

Begins on page 158

Hoisting and pulling machine

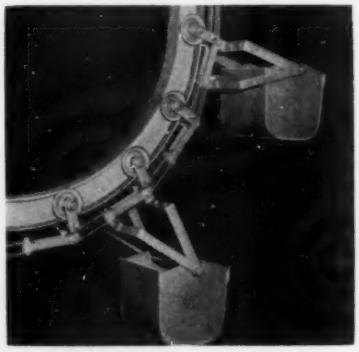
714 • This patented *Tirfor* hand-worked hoist and puller develops 3300 lbs nominal pull. Small enough to be carried and operated by one man, the entire unit, without the ½-in. cable, weighs 42 lb.

To operate, clutch is released and cable threaded through the machine. Clutch is then engaged and machine can be used for hoisting, pulling or lowering the load when proper lever is actuated.

Cable travel is 2¾ in. for each lever stroke, and 77 lbs effort on the lever handle will lift 3300 lbs. Pull can be multiplied by using additional block and tackle.

The two smooth steel jaws that act on the rope are designed on the jaw vise system. They work alternately; one pair cannot release cable before other pair holds.

Princeton Griphoist, Inc, 32 George St, Boston 19, Mass.



Bucket trolley conveyor

757 • New type multiplane bucket trolley conveyor has a patented *stif-arm* bucket hanger design. Trolley may run in horizontal, inclined, or vertical position, or may have sections in all three directions.

A second *stif-arm* bracket brace holds the bucket trunnions at a fixed distance from trolley chain. Buckets rotate around their trunnions, remaining upright at all times until they reach tipping rollers at discharge points. Bulletin MT-251.

Hapman Conveyors, Inc, Kalamazoo, Mich.

Aluminum solder

711 • New type solder, *AluTin 51*, has been developed for production, filling, sealing and repair operations on wrought and cast aluminum alloys. Core of this specially compounded alloy is a liquid flux having exceptional wetting properties, according to manufacturer. Surface tension is reduced, permitting the alloy to spread and flow out wherever the liquid flux has wet the surface. Accelerated tinning action facilitates bonding and permits high strength, porosity-free deposits to be made. Melting range is between 400 and 500 F and the alloy has a tensile strength up to 7000 psi. Any type of heat source may be used. Solder may also be used on steel and other metals.

Eutectic Welding Alloys Corp, 40-40 172nd St, Flushing 58, N. Y.

Nickel-iron battery charger

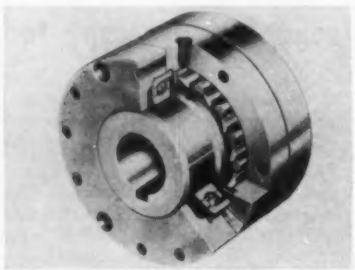
721 • *Precision-Charge* line is designed to charge *Edison* nickel-iron industrial truck batteries. Three models are available to cover charging requirements for batteries of 10 to 42 cells. *Model S9640* is designed for batteries of 10 to 15 cells used with the walkie-type truck and trucks for light work and short hauls. *Model S6088* is for 10 to 30 cell batteries for heavy-duty trucks of both the walkie and rider type. *Model S9607* charges nickel-iron-alkaline batteries with 21 to 42 cells, used in heavy-duty trucks. It has 450-900 amp-hr capacity.

Precision-Charge machines give a constant current charge as recommended by battery manufacturer for top efficiency in operation. The correct charging rate for any battery is set with a single charging current control.

Chargers are motor-generators of compact design and welded steel construction. Models *S-9640* and *S-6088* have a vertically mounted armature, the upright requiring only 3½ sq ft of floor space. Model *S9607* is a horizontal type machine. Construction is drip-proof and all electrical and rotating parts are enclosed.

Lincoln Electric Co, Cleveland 17, Ohio

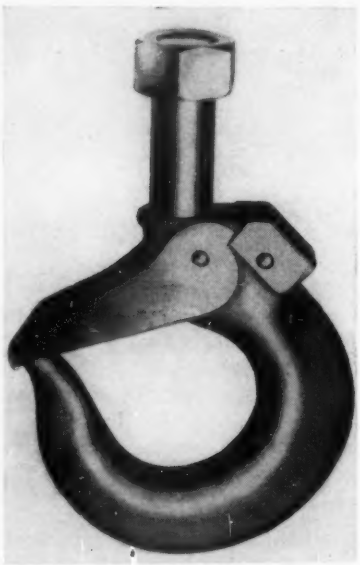
For more data on these items, use post cards p 167. Identify your request with item number.



Overrunning clutches

705 • Cam clutches, Mc series, are used for heavy duty indexing, overrunning and backstop machine drive applications. Self-contained units include two ball bearings that maintain concentricity of inner and outer races, thus avoiding need for additional bearings to support ends of shafts that the clutches control. Tapped holes at ends of clutches provide for cap screw or studs for attaching sprockets, gears, pulleys or ratchet arms for particular drive requirements from 60 to 545 ft-lbs.

Morse Chain Co, 7601 Central Ave, Detroit 10, Mich.



Safety hook

761 • When this new safety hook is engaged, a stamped steel latch swings down and is securely held in place by a lock under spring tension. Slight pressure on the release unlocks the latch, and spring tension on the release holds the latch open. Hook itself is made of drop-forged, heat-treated alloy steel with cadimum plating.

Coffing Hoist Co, Danville, Ill.

Revere Extruded Shapes help increase ELECTRIC GENERATOR OUTPUT

(perhaps you, too, could use our shapes to your advantage)

Model section of G.E. direct-cooled rotor for turbine-generator. Note intake scoop at left front, hollow copper conductors of extruded shapes, in center, exhaust outlet at right rear.

Insert shows typical extruded shapes after milling by G.E. to provide circulation of hydrogen throughout the field coils.

Winding temperatures are an important limitation upon the output of electric utility generators. They must be kept within safe limits to avoid damaging the insulation. Hence all generators have some method of cooling. Conventionally, the heat passes from the copper conductors in the rotor, through the insulation (which presents a formidable barrier to heat transfer) to the steel parts of the rotor body, and air or hydrogen is pumped through and around the rotor. It was realized long ago that more effective cooling could be obtained if some way could be found to remove the heat directly from the rotor coils.

Some years ago generator engineers of the General Electric Company, Schenectady, New York, proposed making each turn of the rotor coils of two copper extruded shapes; one a channel, the other comb-like. Fitted together, they would make hollow passages for the hydrogen, which would be taken in through scoops on the surface of the rotor, and exhausted through outlets some distance away, also on the rotor surface. In that way, the rotor could be quite uniformly and more effectively cooled throughout its length, and output greatly increased in relation to the physical dimensions of the generator.

An important problem was found in the extruded shapes. Design requirements had to be adjusted to the opportunities and practicalities of the extrusion process. Today these copper shapes, 20 feet long, drawn and finished to strict specifications as to dimensions and straightness, are making it possible to remove four times as much heat as conventional systems, and to double the generator output with no increase in size... For full information on extruded shapes, see the nearest Revere Sales Office.

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Founded by Paul Revere in 1801

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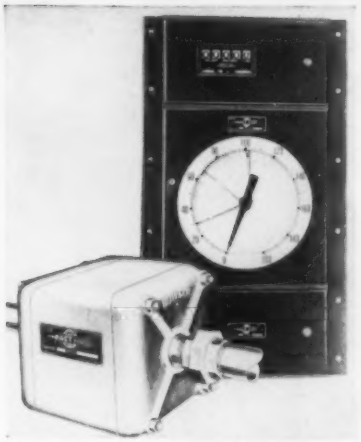
Mills: Baltimore, Md.; Chicago and Clinton, Ill.; Detroit, Mich.; Los Angeles and Riverside, Calif.; New Bedford, Mass.; Rome, N. Y.— Sales Offices in Principal Cities, Distributors Everywhere.

SEE "MEET THE PRESS" ON NBC TELEVISION, SUNDAYS

More EQUIPMENT NEWS

Begins on page 158



Electro-magnetic flow meter

742 • *Xactronic* flow meter permits measurement of a great variety of conducting liquids. High pressures and temperatures or a high concentration of suspended matter present no obstacle.

The metering element consists only of an enclosed magnet, stainless steel tube, and electrodes that are connected to the indicator or recorder, remotely installed. Unit is identified as Fig. 950.

Bowser, Inc, Fort Wayne, Indiana

Selenium rectifier

765 • Constant voltage selenium rectifier is rated at 28 volts, 30 amps and is adjustable from 21.8 to 30.8 volts. Electronically-controlled saturable-core reactor is used for fast recovery and close regulation. Recovery time is 0.2 seconds and regulation of 0.2% with a fixed load and variable line of ± 10% or a fixed line and variable load of 3 to 30 amps; for no load the regulation is slightly higher. Unit operates from line source of 115 volts, single phase, 50-60 cycles. Full information is available.

Richardson-Allen Corp, 39-15 Main St, Flushing, N. Y.

Seamless tubing steel

755 • Alloy steel most commonly used in jet engines, experimental aircraft and gas turbines is now commercially available for high stress and temperature service. It has good strength up to 1200 F, and is mostly austentic stainless steel with chromium, nickel, molybdenum, tungsten and small quantities of columbium, tantalum and titanium. Corrosion resistant, it has characteristics of high carbon, 18% chromium, 8% nickel stainless steel.

Tests at 1200 F show stress to rupture at time periods:

Time to rupture	*Stress*
10 hrs	50,000 psi
100 hrs	44,000 psi
1000 hrs	37,000 psi
10,000 hrs	31,000 psi

and, stress for secondary creep rates:

Creep rate	*Stress*
0.01% per 1000 hrs	9,800 psi
0.10% per 1000 hrs	19,500 psi

Metals such as titanium and some stainless steels can be made into tubes by extrusion, when difficult by rotary piercing.

Babcock & Wilcox, 161 E 42nd St, New York, N. Y.

Roller-chain sprockets

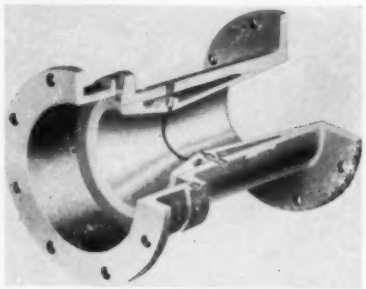
759 • Off-the-shelf line of *Taper-Lock* sprockets has been extended to include the 1½, 1¾ and 2-in. pitch sizes. Sprockets and bushings are now available for chain sizes from 40 through 160.

All new sprockets, through the 26-tooth size, will be close-grained semi-steel.

The sprockets have no flanges or protruding parts. They mount on the shaft quickly and easily and are said to hold with the firmness of a shrunk-on fit. Bushings may be reused. New bulletin supplement gives sizes, weights, dimensions.

Dodge Mfg Corp, Mishawaka, Ind.

For more data on these items, use post cards p 167. Identify your request with item number.



Flow metering tube

747 • A metering device known as the *Dall Flow Tube* has been designed for use with gases and liquids carrying no settleable solids. It consists of a short, flanged cylindrical body with an abrupt decrease in diameter, followed by a conical restriction and diverging outlet.

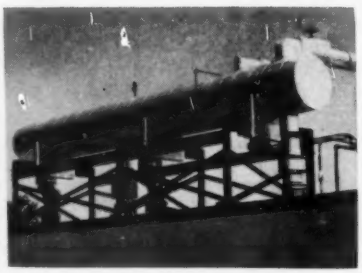
Features include: Lowest permanent head loss of any known differential producer of the velocity increaser type, easy installation, minimum maintenance, and low cost. For capacity tables and head loss data, write to manufacturer.

Builders-Providence, Inc, 345 Harris Ave, Providence 1, R. I.

Aluminum jacketing

746 • Aluminum jacketing for protecting insulated pipelines and equipment is called *Al-Cor-Jac*. Material is vapor, weather, vermin and fireproof. Corrugated for strength, expansion, and contraction, the material is light and easy to handle. In cleaning operations, jacketing can be hosed down with rest of plant. It is particularly valuable in high humidity areas.

Aljon Mfg Co, Inc, Chestnut St & Highland Pkwy, Roselle, N. J.

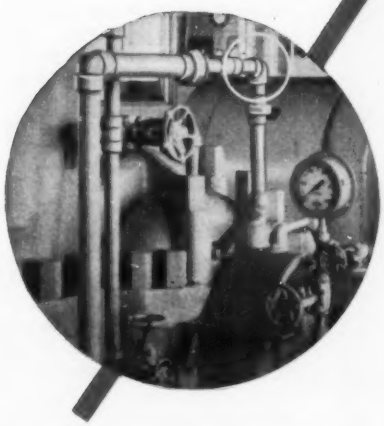


CHECK THESE TOO . . .

Air Purifier . . . . . p 172
Circuit Breaker . . . . . p 174
Plug Valve . . . . . p 176
Seatless Piston Valve . . . . . p 178
Power Transformer . . . . . p 180
Miniature Clutch . . . . . p 182
Battery Charger . . . . . p 184

CLOSE-UP VIEW of a HIGH SAFETY FACTOR

Against Costly Piping Failures



In power plants, chemical plants, refineries and other systems operating at high pressures and temperatures, W-S Forged Steel Fittings help protect the large investment in operating equipment. They provide a high safety factor against costly piping failures and plant down-time. They're drop-forged for *high strength* and *toughness*—the right combination of properties to withstand pressure, heat, shock, vibration and erosion. They're designed for extra strength, too—with extra heavy sections where you need them. And they're precision machined for perfect alignment.

Make Watson-Stillman Forged Steel Fittings your standard for safe, reliable operation of plant equipment. To suit any service and fabrication requirements, W-S Fittings are available in both Screw-End and Socket-Welding types in carbon, stainless and alloy steels. Write today for informative bulletins.

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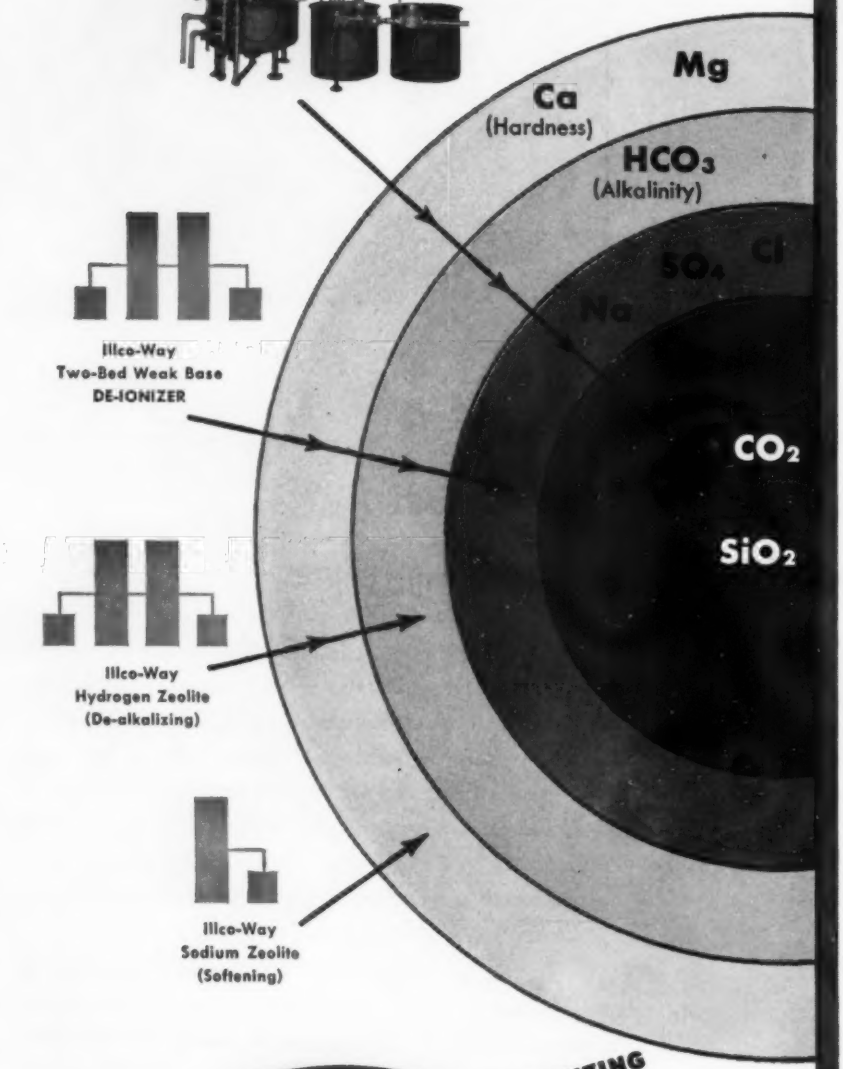
WATSON-STILLMAN FITTINGS DIVISION

H. K. PORTER COMPANY, INC.

Roselle, New Jersey

Even Silica and CO_2 are removed with

ILLCO-WAY **MIXED-BED** DE-IONIZER



ILLCO-WAY DE-IONIZING DE-ALKALIZING SOFTENING

ionXchange

ILLINOIS WATER TREATMENT CO., 853-7 Cedar St., Rockford, Illinois • 141 E. 44th St., New York 17, N.Y.

Canadian Distributor: Pumps & Softeners Limited, London, Ontario

(Advertisement)

MIXED-BED strikes at the very heart of the water purification target . . . produces an effluent with solids reduced to a fraction of a ppm, and Silica and CO_2 removed. *If you require maximum purity in water,* get the facts about this exclusive Illco-Way ionXchange development.

Send for Bulletin A-353 ☐

TWO-BED DE-IONIZING. In the late '30's, Illco-Way fabricated and installed the first commercial De-ionizer utilizing cation and anion exchange. Equipment produces excellent water for process application where the equivalent of distilled water is required.

Send for Bulletin A ☐

HYDROGEN ZEOLITE process for removal of calcium and magnesium ions and alkalinity. This Illco-Way equipment efficiently conditions water for low-pressure steam boilers and for chemical processes where soft, alkaline-free water is required.

Send for Bulletin P-30 ☐

ZEOLITE SOFTENING for removal of hardness is the basic ionXchange process which industry has put to widespread use for many years. Improvements in equipment and exchange material now provide even greater economies where soft water is required.

Send for Bulletin S-105 ☐

Pioneers in ionXchange

Illco-Way "firsts" include manufacture of the first commercial two-bed De-ionizer . . . the first commercial mixed-bed De-ionizer . . . and the development and building of the first successful installations for the purification of such liquids as beet juice and crude glycerol by ionXchange. . . . In the power field, boiler feed water treatment by Illco-Way ionXchange has long meant lower operating costs and increased operating efficiency. Installations are found in leading plants.

For complete literature in specific fields, send for catalogs listed above.

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AIR CONDITIONING, HEATING

1 **Heating and ventilation units,** catalog 1620, and air conditioning units, catalog 1630. Two 40-page booklets on moving, heating or cooling air. Westinghouse Electric Corp, Sturtevant Div, Dept T-126, 200 Readville St, Hyde Park, Boston 36, Massachusetts.

2 **Unit heaters.** Gas fired, warm air units with output capacities of 88,000 to 160,000 Btu per hr. Four page bulletin 543-B, Dravo Corporation Heating Dept, 1203 Dravo Building, Pittsburgh 22, Pa.

3 **Heat extractor,** TX-50, for cooling liquids between 85 and 160 F. Photos, construction and specs. Four page bulletin HE-1, Mayer Refrigerating Engineers, Inc, Lincoln Park, N. J.

4 **Oil burner** with 17.5 gph capacity. Photos and applications to industry. Two-color bulletin AD-131, Cleaver-Brooks Co, 326 E Keefe Ave, Milwaukee 12, Wis.

5 **Control centers** for improving installation of controls for heating, ventilating and air conditioning. Photos, diagrams and applications. Two-color 8-page bulletin F 5265-1, Barber-Colman Co, Rockford, Illinois.

6 **Unit type collectors** as opposed to centralized system for dust control. Photo and case history. Single page bulletin 640-4, Aget-Detroit Co, Ann Arbor, Mich.

BOILERS AND AUXILIARIES

7 **Small boilers.** Manufacturers' CB line available in 15 to 40 hp (15 to 150 psi steam, 30 psi hot water) for heating and processing. Photos and specs. Two color 4-page bulletin AD-134, Cleaver-Brooks Co, 326 E Keefe Ave, Milwaukee 12, Wis.

8 **Level controls** and related boiler safety devices. Photos, engr data and complete specs in 24-page catalog SC-5. McDonnell & Miller Inc, 3500 N Spaulding Ave, Chicago 18, Ill.

9 **Instrumentation for steam generation.** Photos, dimensions and specs of all products applicable to steam generation. Two-color, 28-page bulletin 9050. Minneapolis-Honeywell Regulator Co, Industrial Div, station 64, Wayne & Windrim Aves, Philadelphia 44, Pa.

10 **Air type burners.** Low pressure, series 620-P, for oil or combination oil and gas. Photos, capacities, dimensions. Two color, 4-page catalog 413, Hauck Mfg Co, 124-136 10th St, Brooklyn 15, N. Y.

11 **Automatic boilers,** packaged units for light oil, gas or combination firing from 15 to 100 hp. Photos and specs. Two-color, 8-page bulletin 1230, Orr & Sembower Inc, Morgantown Rd, Reading, Pa.

12 **High pressure strainers** for steam and boiler feed pressure above 900 psi. Photos and specs. Two-page bulletin supplement 9S-HP, Schutte & Koerting Co, Cornwells Heights, Bucks County, Pa.

13 **Firing controls** for automatic regulation of boiler pressure. Fires either oil or gas, one or more boilers. Photos, diagrams and specs. Two-color, 10-page bulletin 8C and price list. Inferno Co, PO Box 1138, 115 Ricou St, Shreveport, La.

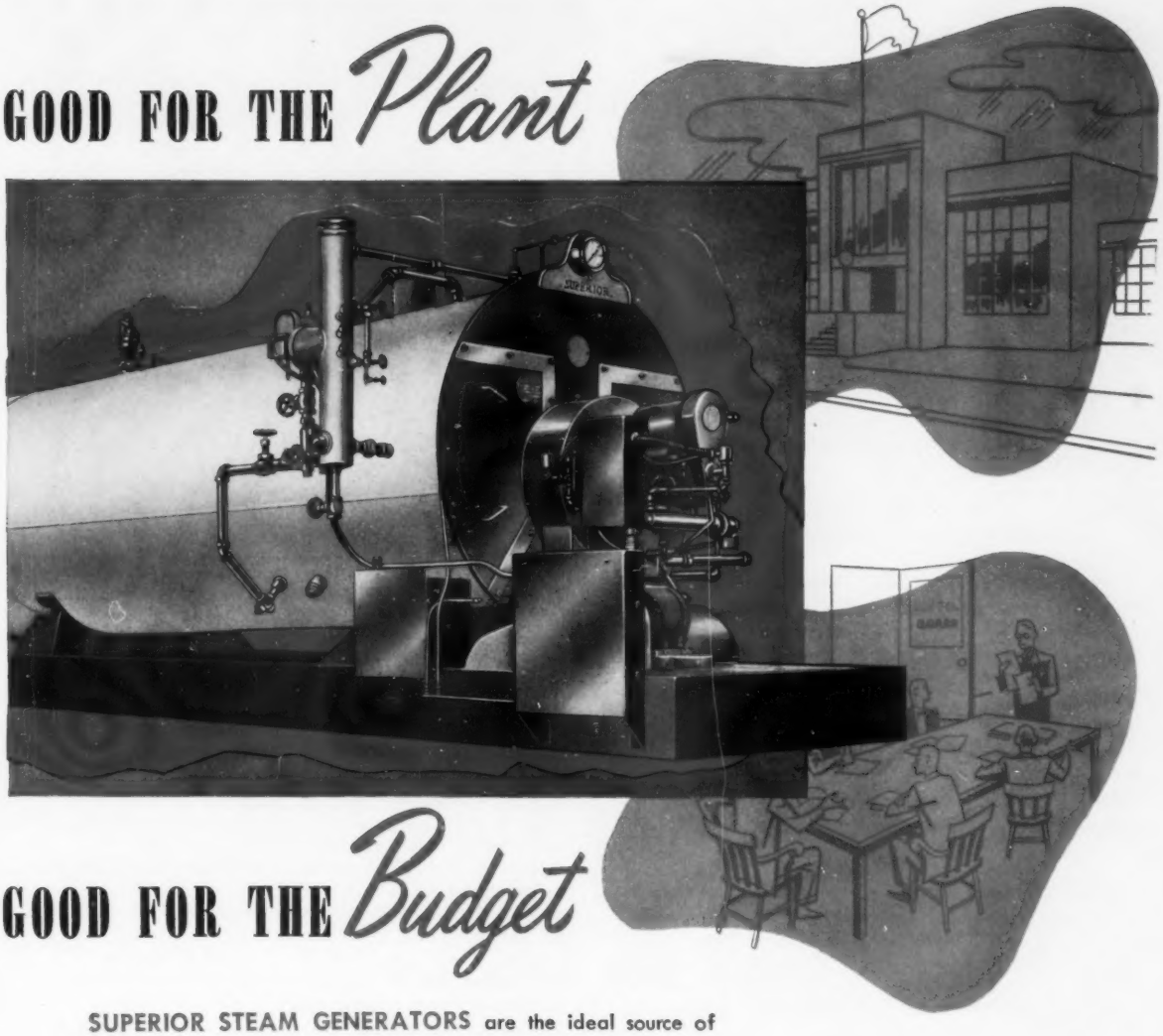
14 **Firecing refractories** for industrial furnaces. Photos, charts and specs. Three-color, 8-page *Coleman* bulletin, Harbison-Walker Refractories Company, Farmers Bank Building, Pittsburgh 22, Pa.

ELECTRICAL CONTROLS

15 **Voltage regulators.** Charts, applications and specs describe station and pole-type regulators, both step and induction design, in 20-page booklet B-6053, Westinghouse Electric Corp, PO Box 2099, Pittsburgh 30, Pa.

(*Continued on page* 240)

GOOD FOR THE *Plant*



GOOD FOR THE *Budget*

SUPERIOR STEAM GENERATORS are the ideal source of steam for heat or process. Completely *factory assembled,* and *factory tested* to insure capacity operation at thermal efficiencies guaranteed to exceed 80%, they are backed by undivided responsibility. Installation is simple and inexpensive. Rugged and compact, they need no special foundation, fit in limited space with low overhead.

Superior's *built-in* induced draft eliminates the need of an expensive chimney and avoids the forcing of combustion gases into the boiler room.

Superior Steam Generators reduce maintenance to a minimum and in many cases earn their total cost in less than 2 years through operating economies resulting from high efficiency.

Dependable, quiet performance, plus economies of installation and operation, make Superior the ideal steam plant.

Fully automatic, Superior Steam Generators burn gas, oil, or both. Sizes from 20 to 600 bhp. for pressures to 250 psi. or for hot water. Battery installations provide maximum flexibility for higher capacities. Write for catalog 600.

for performance you can **BANK** *on*

SUPERIOR COMBUSTION INDUSTRIES INC.
TIMES TOWER, TIMES SQUARE, NEW YORK 36, N.Y.

SUPERIOR
STEAM GENERATORS

George Edwards' Scrapbook

Do engineers make good executives? *Here is how Dr R F Pearse of Worthington Associates answered this question:*

"Some investigators of engineers as potential executives take a pretty dim view of the situation. They say that engineers often just aren't geared for effective direction of others. Yet, our industrial society forces the engineer to become an executive because his technical know-how forms a keystone in America's complex industrial system.

"Personality traits common to engineers are (1) insistence on always being right (2) hostility toward authority figures (3) avoidance of close inter-personal relationships (4) limited effectiveness in getting results through others.

"By increasing their understanding of themselves, engineers can get better results in directing people and in exercising the important executive function of working with and through others."

Now I know why my co-workers cross the street whenever they see me coming.

* * *

When Dan Boone reached the ripe old age of 93, a well-known artist looked him up in the Kentucky woods in order to paint his portrait. "Did you ever get lost while exploring this wild country?" asked the artist.

After some thought, Boone replied, "I ain't never been lost, but I was mighty bewildered once—for three days."

While most of us won't admit being lost, I guess we've all been pretty much "bewildered" in some plant at one time or another.

DID YOU KNOW that George Selden, an American, applied for a patent on a motor vehicle propelled by an internal-combustion engine in 1879? This was 6 years before Daimler and Benz in Germany built the vehicles from which the modern history of the automobile is traced.

Selden's patent was issued in 1895 after other Americans had built successful gasoline automobiles. However, many makes of our early cars were manufactured by license under the Selden patent. A few independent pioneers refused to admit its validity and one of the most famous patent suits of all times resulted.

In 1911, the Selden patent was declared valid but not infringed as none of the manufacturers sued had used the Brayton type of engine described in the Selden patent.

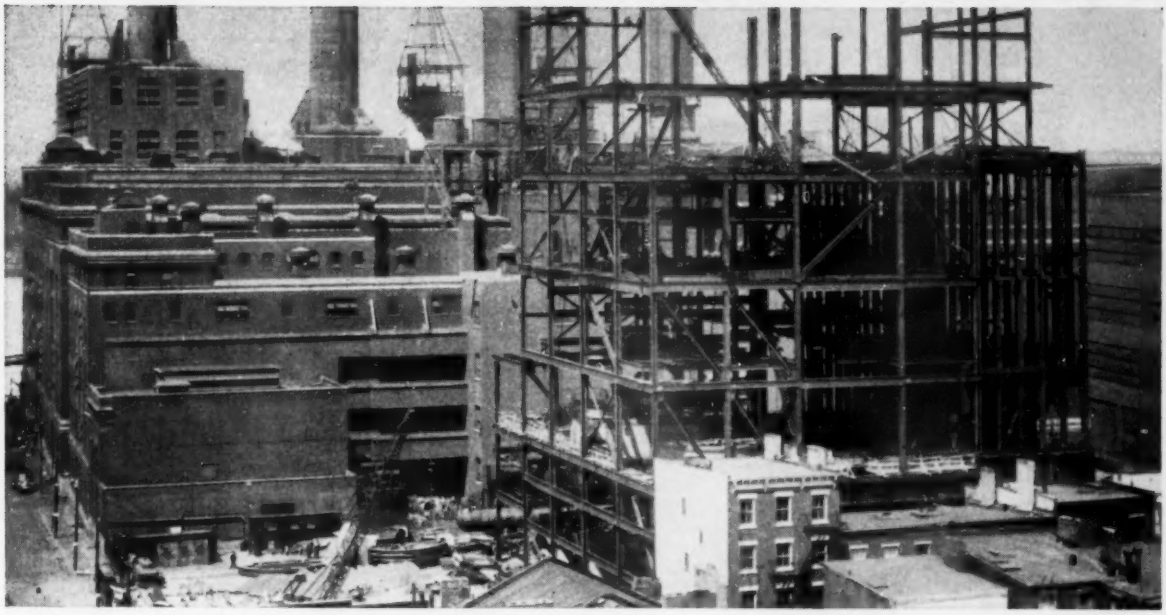
Above, S H Oliver of the Smithsonian Institution in Washington, D.C. is showing the original Selden patent model to a young museum fan.

If you haven't visited the engineering exhibits of this great institution. I strongly urge you to do so. You will see the granddaddies of many pieces of equipment you work with daily in your power plant. Take the kids with you. You'll all have fun—learn a lot.

It's easy for misinformation to get into print, as every engineer knows. Tell a group of people something, and each seems to interpret it his own way, and at least one will have it all balled up. I guess the prize example took place at the 1951 meeting of the American Association for the Advancement of Science. One of the speakers scoffed at Russia's Lysenko for claiming to have planted wheat that, through effects of Soviet environment, changed to rye.

"This," said the speaker, "is as if a cat were to give birth to a lion." A London newspaper announced in all seriousness next day that: "It is reported in Philadelphia that the Russians made a cat give birth to a lion." And no doubt some people believed it.

George Edwards
Engineer



CHEMICAL CLEANING REMOVED MILL SCALE FROM BOILER AFTER ERECTION

Dowell Service gave quick, effective cleaning assuring more efficient operation

To provide more extensive service for its customers, a large power company installed a new 1,370,000 lb. per hour boiler. Specifications on this equipment called for Dowell Chemical Cleaning Service to remove any oil, grease, protective coatings, mill scale and rust from the boiler after erection.

To accomplish the purpose, Dowell engineers filled the boiler with solvents especially designed for the job. Using Dowell's equipment, manpower and pump trucks, the entire cleaning job was performed in a few hours.

Dowell has removed as much as three thousand pounds of mill scale and iron oxide from a new boiler.

Unless it is removed, mill scale may retard heat transfer, slough off abrading particles, and act as a base for corrosion. And considerable annoyance may result from black boiler water. The removal of mill scale after equipment is erected can also eliminate much of the extra care required in the handling of previously sand blasted or pickled tubes.

Maintenance engineers in industrial plants throughout the country have learned to rely on Dowell Service for fast, effective and economical cleaning of their operating equipment. How about you?

Experienced Dowell engineers are available to make estimates on your particular problems. Call Dowell today, or write to DOWELL INCORPORATED, Tulsa 1, Okla., Dept. G-23.

DOWELL SERVICE

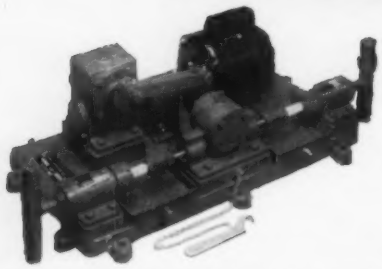
chemical cleaning service for industry

DOWELL

A SERVICE SUBSIDIARY OF THE DOW CHEMICAL COMPANY

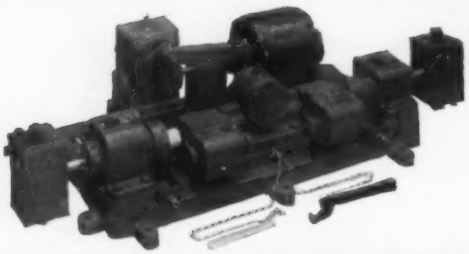
If you meter or proportion small volume flows...

THERE IS A HILLS-McCANNA "U" TYPE PUMP TO DO THE JOB



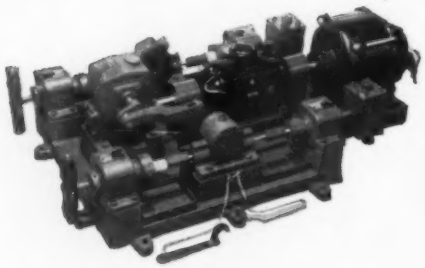
STANDARD 1, 2, 3 or 4 FEED UNITS

Standard "U" Pumps are available in maximum capacities from 0.10 to 24.0 gal. per hr. per feed. Operating pressures from 125 to 5000 psi.



JACKETED UNITS

For handling materials that require heat or refrigeration, "U" Pumps can be supplied with either or both jacketed liquid ends and check valves.



VARIABLE SPEED UNITS

"U" Pumps can be furnished with a variable speed drive which permits varying capacity remotely or automatically when combined with the proper auxiliary equipment.

Write for Catalog:

Catalog UP-52R gives full data on all sizes and types of Hills-McCanna "U" Type Pumps. Write for a copy, today. Hills-McCanna Co., 2369 W. Nelson St., Chicago 18, Ill.

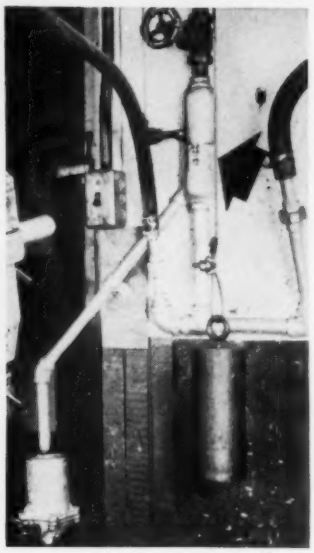
HILLS-McCANNA

metering and proportioning pumps

Also Manufacturers of:
SAUNDERS TYPE DIAPHRAGM VALVES
FORCE FEED LUBRICATORS • MAGNESIUM ALLOY SAND CASTINGS

More EQUIPMENT NEWS

Begins on page 158



Maintenance-free air purifier

739 • Purifier keeps dirt and moisture out of air tools and other pneumatic equipment; is said to require no maintenance. *Type LC Hi-eF purifier* removes dirt and moisture by means of a combination centrifugal and baffle-type separating element inside a forged steel body. This eliminates need for filters.

Once the unit is installed in the air line there is no need to periodically clean the unit or even inspect it, manufacturer claims. Liquids and solids are automatically drained away by a float-type trap.

V D Anderson Co, 1935 W 96th St, Cleveland 2, Ohio

For more data on these items, use post cards p 167. Identify your request with item number.

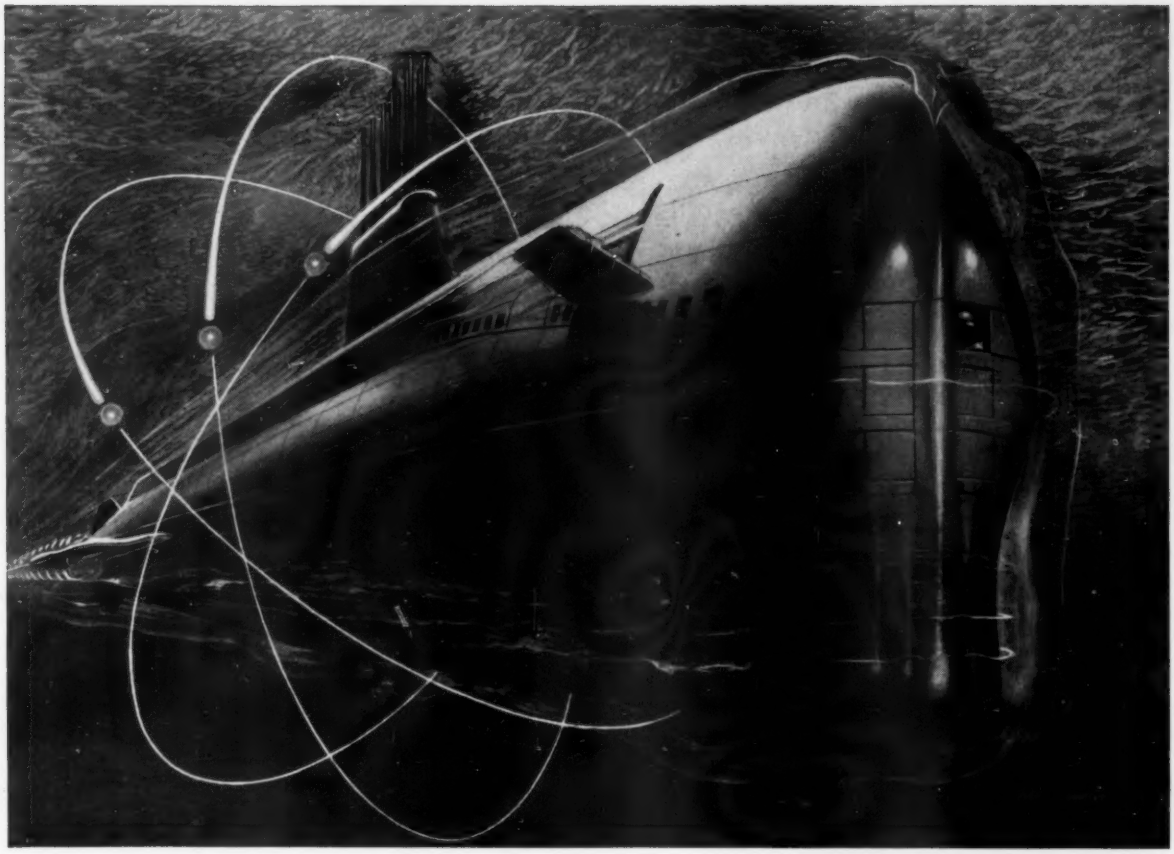
Ball-bearing pillow blocks

760 • New ball-bearing pillow blocks with pressed-steel housings are designed for low-speed light-load applications. Precision deep-groove single row ball bearings are self-aligning in all directions.

Series JPS-200 pillow blocks are available for shafts from ⅝ to 1¼-in. diameter. Installation is accomplished by slipping the inner ring on shaft and locking it in position. Rubber lip-type seal retains the lubricant and excludes dirt. Folder 2517.

Link-Belt Co, 307 N Michigan Ave, Chicago 1, Ill.

(*Continued on page* 174)



ATOMIC SUB BUILDERS

Rely on World's Greatest Lubrication Knowledge and Engineering Service

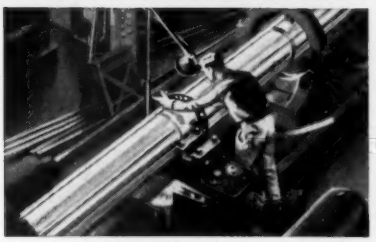
AFTER 54 years of building over 300 "conventional" submarines for the U. S. Navy and our allies, Electric Boat Division, General Dynamics Corp., marks its entry into the atomic age with the launching of the "Nautilus"—world's first atomic powered submarine.

Electric Boat, with its sprawling foundries and shops along the Thames River at Groton, Conn., is really many industries in one. It casts its own metals—both ferrous and non-ferrous. It shapes and machines metal parts—from thick armor plate to parts with microscopic tolerances. It has 27 overhead cranes, marine railway and land railroads, a fleet of trucks, low- and high-pressure compressors, its own Diesel power plant.

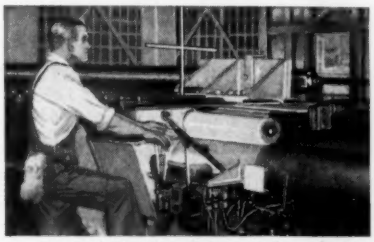
This wide variety of costly machinery represents almost every lubrication condition found in modern industry. That is why Electric Boat relies 100% on Gargoyle lubricants and a program of Correct Lubrication—has done so for 34 years.

★ ★ ★

You can give your plant, mine or mill this same unsurpassed protection. Just call your Socony-Vacuum representative.



A snorkel intake tube being machined to very precise tolerances on one of the large lathes in the Groton plant.



Hydraulic bender shapes section of 8-in. steel pipe in two minutes. This operation formerly took a full day.

SOCONY-VACUUM *Correct Lubrication*

FIRST STEP IN CUTTING COSTS

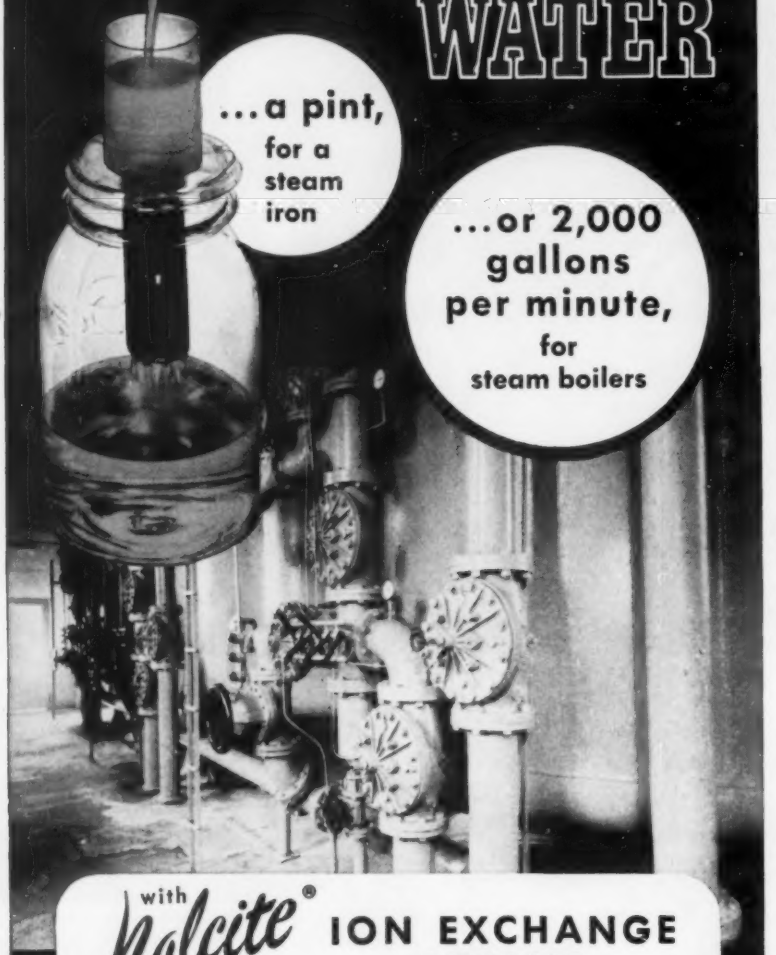
SOCONY-VACUUM OIL CO., INC., and Affiliates: MAGNOLIA PETROLEUM CO., GENERAL PETROLEUM CORP.

SOCONY-VACUUM

DEIONIZED WATER

...a pint, for a steam iron

...or 2,000 gallons per minute, for steam boilers



with Nalcite® (DOWEX*) ION EXCHANGE RESINS

From the small jobs of providing pure water for home steam irons to the big ones of producing silica-free deionized water at 2,000 gallons per minute for large steam generators, Nalcite Cation and Anion Exchange Resins perform with a dependability and efficiency that command confidence throughout the industry.

Facts on Nalcite HCR Cation Exchange and Nalcite SAR and Nalcite SBR Anion Exchange Resins are yours for the asking. Write today for bulletins 57, 58, and 60.

*Registered Trademark of the Dow Chemical Company

NATIONAL ALUMINATE CORPORATION
6222 West 66th Place • Chicago 38, Illinois
In Canada: Alchem Limited, Burlington, Ontario

nalco PRODUCTS

When you use Nalcite resins, you take advantage of Nalco's long and broad experience in water and process technology.

More EQUIPMENT NEWS

Begins on page 158

Circuit breaker: 10-50 amp

766 • New 2-pole *EQ* circuit breaker is designed for panelboards, load centers or individual enclosures. Double-pole combines thermal and magnetic tripping; thermal action guards against small overloads while magnetic trip protects against short circuits. Common tripper bar arrangement replaces handle tiebar previously used to join two single pole breakers together. Available in ratings from 10-50 amp; 120/240 v ac; 5000 amp interrupting.

I-T-E Circuit Breaker Co, 19th & Hamilton Sts, Philadelphia 30, Pa.

For more data on these items, use post cards p 167. Identify your request with item number.

Dielectric Test Set

767 • Portable field instrument measures dc current at voltages up to 40 kv when applied to insulation of generators, transformers, busl ing and cable. Set has current rating of 25 milliamperes at short circuit, and current measurements can be made down to 0.5 microamperes. All high voltage components are oil immersed. Overall dimensions: 19½-in. high, 13½-in. wide, 20-in. deep. Bulletin 22-24.

James G Biddle Co, 1316 Arch St, Philadelphia 7, Pa.

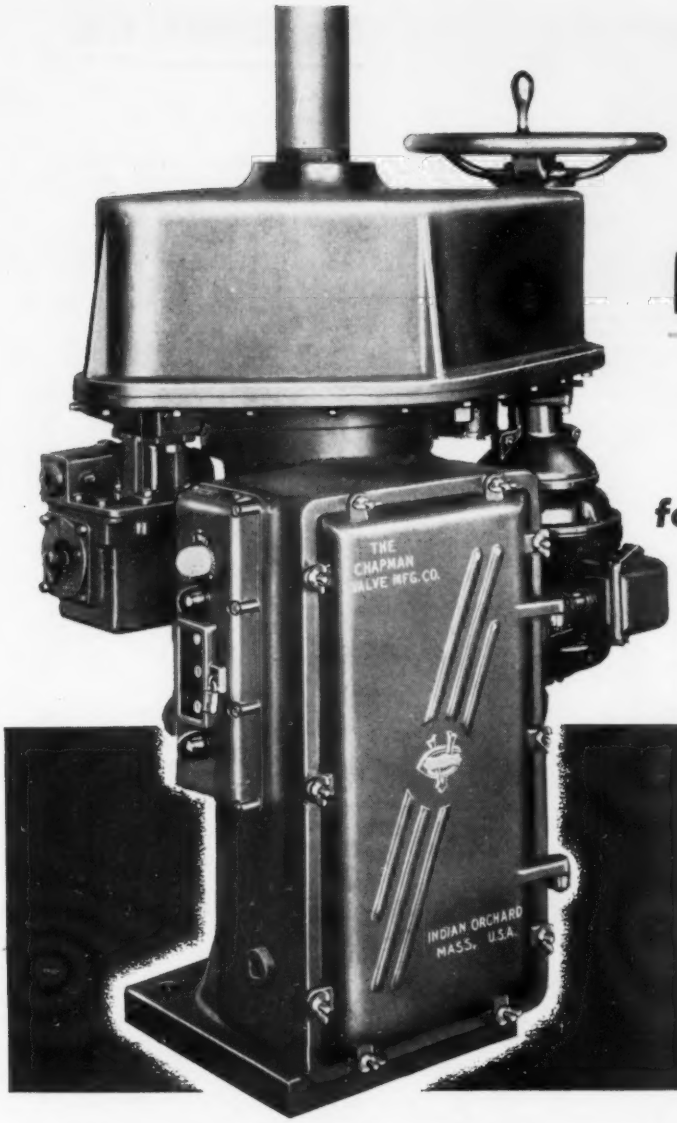
Fuse reducer fitting

720 • Line of fuse reducers makes possible use of standard or dual-element cartridge fuses of sizes smaller than fuse clips are

Simple and RUGGED...

CHAPMAN'S MOTOR UNIT

for Valves, Floorstands and Sluice Gates



Floorstand equipped with Motor Unit . . . control panel, motor, limit switch and push button station.

Simple, durable mechanism of Chapman's Motor Unit. Handwheel remains stationary during motor operation.

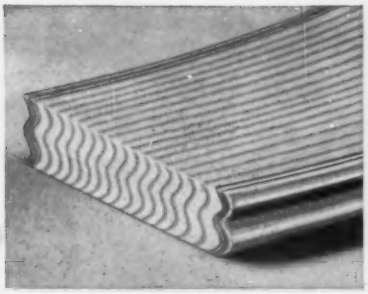
Chapman Motor Units have fewer components than any other units, providing greater dependability, much lower maintenance costs.

There are only two pinions and two gears in the motor reduction train: drift is eliminated and lash is negligible. Your valves seat tight, but not too tight. Operation is *always* smooth and trouble-free.

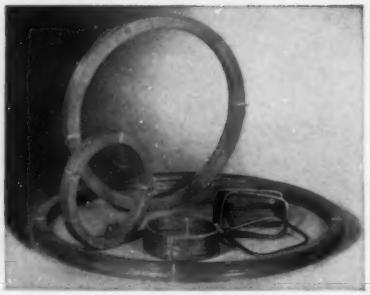
You can mount the Chapman Motor Unit in any position, at any angle required. The rugged stub-tooth gears require no grease or oil bath . . . yet run smoothly, quietly, with minimum wear.

Weatherproof and steam tight, Chapman's floorstand units are shipped completely wired, ready to connect to your power leads, for easy, rapid installation. This modern motor unit is dependable and economical. Send for *new* catalog No. 51.

The CHAPMAN Valve
Manufacturing Company
INDIAN ORCHARD, MASSACHUSETTS



Cross section view of the GUARDIAN gasket shows its unique and rugged construction—alternate layers of metal and asbestos. The inner and outer edges are reinforced with two or more thicknesses of metal. For use against acids and other chemicals, GUARDIAN gaskets are made of stainless steel with "Teflon" filler.



GUARDIAN gaskets are made in round, oval, square, flatside, diamond, and pear shapes. They are furnished in a wide range of sizes for pipe flanges, boilers and other equipment. For raised face pipe flanges, GUARDIAN gaskets with metal centering rings are recommended.

Keeps joints tight automatically, regardless of temperature changes

Guardian* Gasket

GUARDIAN gaskets assure *permanently* tight joints because they compress and rebound instantly and repeatedly. Thus, they conform with expansion and contraction caused by changes in temperatures. The need for retightening joints is greatly reduced resulting in *less* maintenance and *longer* gasket life.

Since GUARDIAN gaskets do not adhere to the flanges, you save two ways: (1) time required to clean the flanges is reduced, and (2) the gaskets can frequently be reused.

GUARDIAN gaskets are unaffected by extreme temperatures and pressures. They offer maximum protection against blow-outs and leaks under *all* service conditions. Get all the facts about GUARDIAN gaskets—call your Garlock representative or write for folder AD-104.

THE GARLOCK PACKING COMPANY, PALMYRA, NEW YORK

Sales Offices and Warehouses: Baltimore • Birmingham • Boston • Buffalo • Chicago • Cincinnati • Cleveland Denver • Detroit • Houston • Los Angeles • New Orleans • New York City • Palmyra (N.Y.) • Philadelphia Pittsburgh • Portland (Oregon) • Salt Lake City • San Francisco • St. Louis • Seattle • Spokane • Tulsa.

In Canada: The Garlock Packing Company of Canada Ltd., Toronto, Ont.

**Registered Trademark*

GARLOCK

PACKINGS, GASKETS, OIL SEALS, MECHANICAL SEALS, RUBBER EXPANSION JOINTS

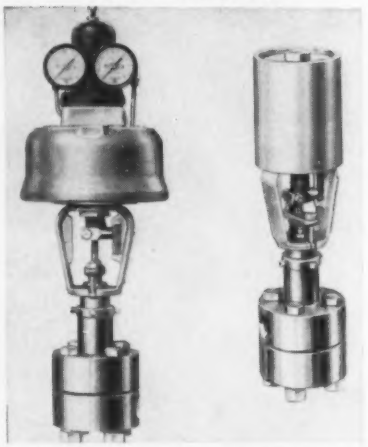
More EQUIPMENT NEWS

Begins on page 158

intended for. They do not take up any more space than regular fuses.

All parts are made of brass or copper to prevent collapsing, spreading or distortion when clamps for fuse clips or set screws are tightened. All sizes with copper blades are electronically silver-alloy brazed for maximum strength and conductivity. Made in sizes for all fuses from 0 to 600 amp both 250 and 600 v. Bulletin No. 8.

Trico Fuse Mfg Co, 2948 N 5th St, Milwaukee 12, Wis.

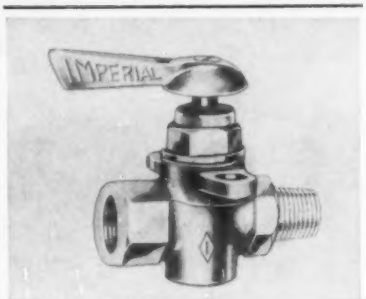


High-pressure control valve

745 • A line of control valves for pressures to 6000 psi and temperatures to 900 F are offered in ½ in. and ¾ in. sizes. Both offset globe and angle bodies are available. Pictured are models 3460, *Domotor* operated, and 3420, cylinder operated.

The Annin Co, 6570 E Telegraph Rd, Los Angeles 22, Calif.

For more data on these items, use post cards p 167. Identify your request with item number.



Plug valve

730 • A plug type valve for pneumatic applications, fluid transmission systems, instrumentation and similar uses features a pressure balanced plug and is recommended for working pressures to 300 psi. Convenient brackets are provided for mounting on instrument panels.

Plug is made of a special nickel silver alloy and is double ground to prevent leakage. Male to female and male to male connections are offered. Bulletin 3024.

Imperial Brass Mfg Co, 1200 W Harrison St, Chicago 7, Ill.

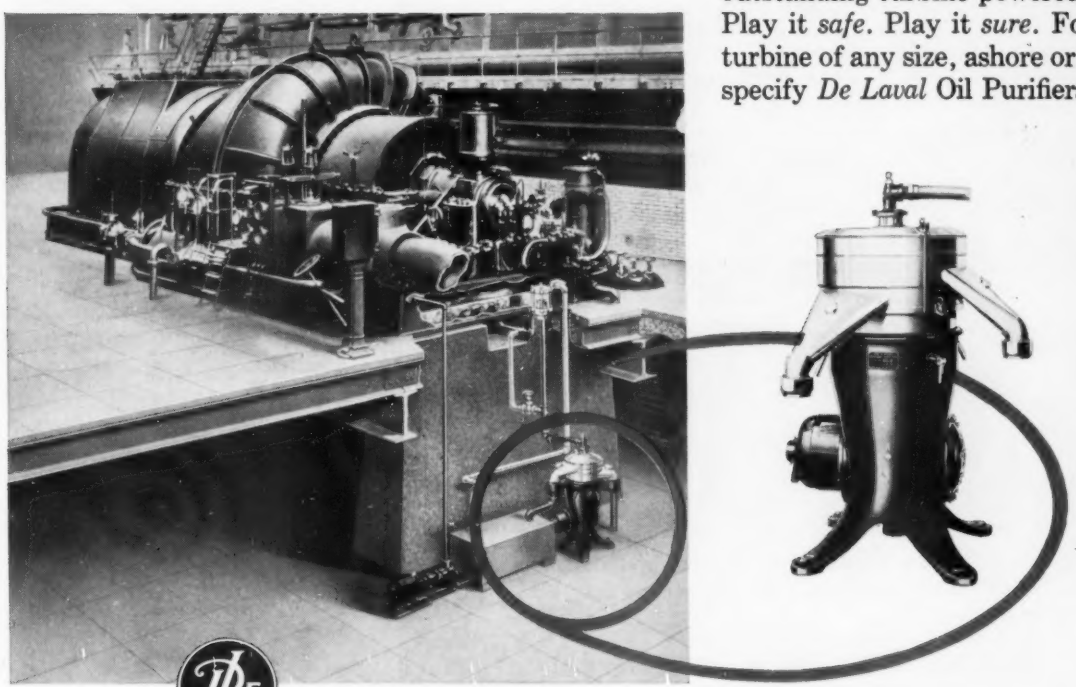
(*Continued on page* 178)

THE PIGMY PROTECTS THE GIANT

The most powerful turbine is at the mercy of the oil that lubricates its bearings and governor mechanism. Let water, sludge, pipe scale or rust get into the oil, or let the oil film strength deteriorate, *and there's trouble!*

De Laval Turbine Oil Purifiers keep the oil clean and maintain full film strength more *effectively* than any other means ever devised. And De Laval gives *dependable* 24-hour a day protection, month after month, year after year.

These are the reasons why De Laval Oil Purifiers are used by the great majority of America's power companies and on most of the world's outstanding turbine-powered ships. Play it *safe*. Play it *sure*. For your turbine of any size, ashore or afloat, specify *De Laval* Oil Purifiers.



DE LAVAL

TURBINE OIL PURIFIERS

for More Dependable Power Production

THE DE LAVAL SEPARATOR COMPANY

Poughkeepsie, New York • 427 Randolph St., Chicago 6 • DE LAVAL PACIFIC CO., 61 Beale St., San Francisco 5

BITUMINOUS BURNS BEST ON LACLEDE CHAIN GRATE STOKERS

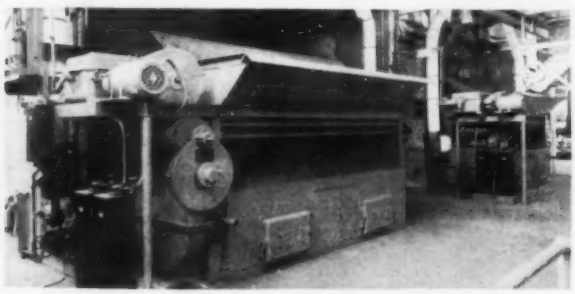
Mid-West bituminous coals, high in volatiles and ash, with low ash fusion temperatures

1. Must not be agitated while burning on the grate, to prevent clinkers.
2. Must be burned on stoker grates designed to insure unobstructed air passages.

Laclede Forced Draft Chain Grate Stokers burn Mid-West bituminous coal best because:

1. The coal is passed through the furnace in a uniform layer, without agitation.
2. The weight and shape of grates, and relative movement between grates passing over idler and drive sprockets, keeps air spaces permanently open.

When Griesedieck Western Brewery rebuilt and modernized their brewery at Belleville, Illinois, they again purchased Laclede Chain Grate Stokers. Low fuel, operating and maintenance costs continue at this modern installation.



Laclede Chain Grate Stokers at Griesedieck Western Brewery Co., makers of Stag beer.

HERE ARE A FEW OF MANY COMPANIES THAT HAVE BOUGHT AND RE-BOUGHT LACLEDE STOKERS.

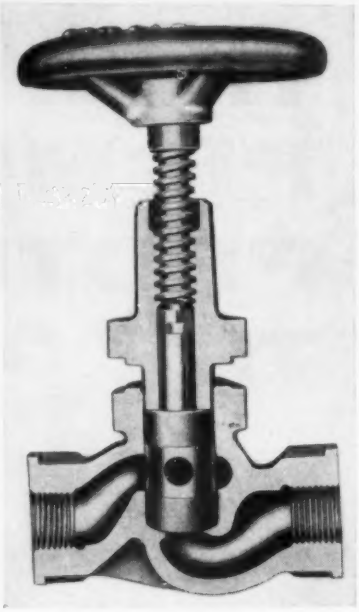
STATE OF INDIANA
INTERNATIONAL SHOE CO.
MAYTAG CO.
PET MILK CO.
UNION STARCH AND REFINING CO.
WABASH RAILROAD CO.

LACLEDE
STOKER COMPANY
4440 HUNT AVE. • ST. LOUIS 10, MO.

Founded in 1904

More EQUIPMENT NEWS

Begins on page 158



Seatless piston valve

749 • *Klingerflow* seatless piston valve is claimed to withstand the highest pressures and temperatures encountered in present day practice. It retains pressure tightness by the fit of a piston sliding through two resilient compressed valve rings. Write to manufacturer for further information.

Klinger Corp of America, Dept 3, 95 River St, Hoboken, N. J.

For more data on these items, use post cards p 167. Identify your request with item number.

Integral strainer trap

744 • This trap, Model No. 882, is said to cost less than a standard trap plus separate Y-type strainer, and fewer fittings are required to install it. It is recommended for use where dirt and scale conditions are bad. Stainless steel strainer screen is in the body casting at bottom of trap. Capac-

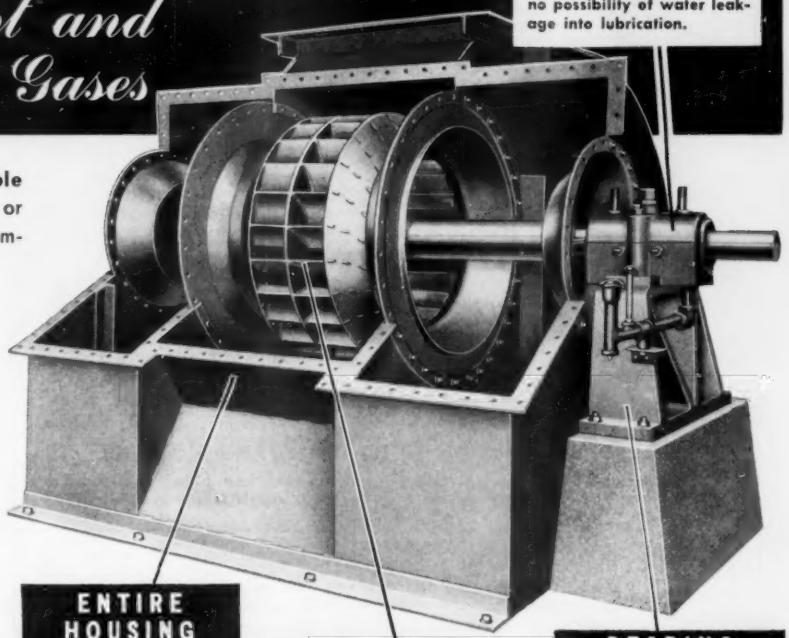
LONG EXPERIENCE

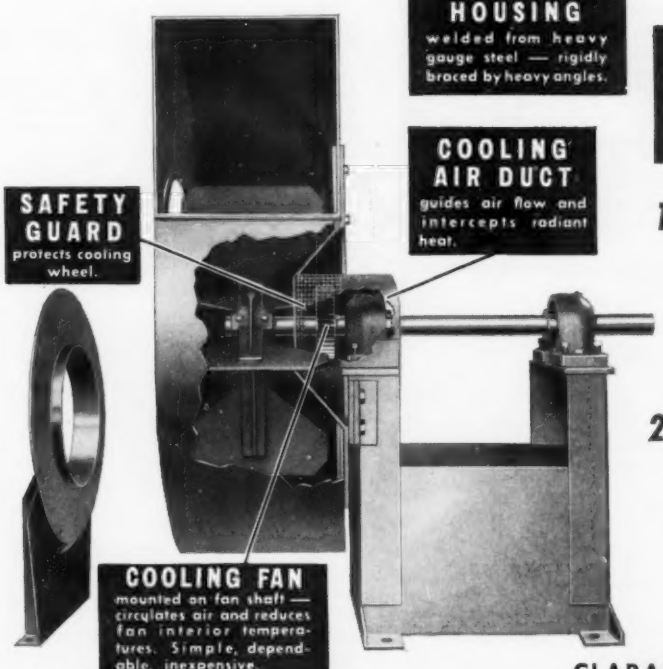
Handling Hot and Medium Hot Gases

You need the BEST fans obtainable — if your job is mechanical draft — or you require high or medium high temperature fans in production.

Fans built by Clarage for these tough jobs are heavier throughout—wheels statically and dynamically balanced, bearings of superior design. Operating economy and longer service without repairs are the natural results.

You do BETTER when you come to Clarage with any problem in this specialized field.


WATER COOLED BEARING
water circulated through each half of inner sleeve — no possibility of water leakage into lubrication.
ENTIRE HOUSING
welded from heavy gauge steel — rigidly braced by heavy angles.
FAN WHEEL
practically one piece welded assembly — with nearly twice the strength of wheels with shallow blades.
BEARING SUPPORT
massive cast iron structure provides permanent alignment to bearings, wheel and shaft.


SAFETY GUARD
protects cooling wheel.
COOLING AIR DUCT
guides air flow and intercepts radiant heat.
COOLING FAN
mounted on fan shaft — circulates air and reduces fan interior temperatures. Simple, dependable, inexpensive.

1) *High Temperature Fans*

Type RT fan (shown above with quarter-section removed) is built to handle air or other gases at any temperature required in power plant work, and to meet many industrial needs. Superior design assures sustained high efficiency, and superior construction makes for trouble-free service far beyond ordinary standards.

2) *Medium Temperature Fans*

Clarage has a unique feature — AIR COOLED bearings which are good for continuous operation at temperatures to 750° F. Air Cooled bearings are highly successful, easy to maintain, and they reduce overall fan cost substantially.

Clarage Air Cooled bearings can be used with absolute confidence.

CLARAGE FAN COMPANY, *Kalamazoo, Mich.*

You can Rely on...

CLARAGE

Headquarters for Air Handling and Conditioning Equipment

SALES ENGINEERING OFFICES IN ALL PRINCIPAL CITIES • IN CANADA: Canada Fans, Ltd., 4285 Richelieu St., Montreal

Choose WESTERN
for Chemical Treatment of Water, Steam and Fuel

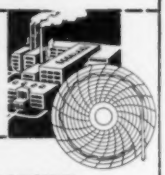
Look them over! Check your needs! Every Western product for treatment of water, steam or fuel is proved in use, technically formulated for each individual problem.

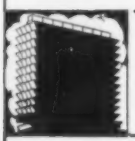
1 *Steam* + CORAVOL® = *Protection* (FROM CORROSION)

CORAVOL circulating throughout your steam system protects it from corrosive attack; cleans out rust deposits; increases heating and operating efficiency; reduces maintenance and labor costs. CORAVOL is the *original amine process* developed by Western Chemical Company.

2 WESTERN BOILER FEED WATER TREATMENT

Special formulas for each individual boiler water and operating condition to eliminate scale, corrosion and foaming.





3 COOLING WATER TREATMENT AND ALGAECIDE

Prevents scale deposit, corrosion, and algae growth in every type of cooling and condenser water system.

4 BRINE AND SWEET WATER TREATMENT

Prevents corrosion and protects tanks and equipment in refrigerating brine and sweet water systems.

5 WESTO HOT WATER TREATMENT

Stops corrosion and scaling in hot water supply tanks and lines, maintaining service without impairing potability.

6 WESTERN LIGHTNING TREATMENT

Disintegrates and removes scale quickly from water jackets, cylinder heads, condensers, compressors, lines, coils, pumps.

7 WESTERN ALUMINA NO. 45

Provides efficient coagulation in raw water ice manufacture, lime and soda softeners, water supply clarification.

8 WESTERN SOOT REMOVER

Removes and prevents soot deposits in combustion areas, thus increasing fuel economy and boiler capacity.

9 WESTERN FUEL OIL SLUDGE DISPERSANT

Eliminates sludge and moisture in fuel oil, effecting clean tanks, lines, and burners, and improved combustion.

Chemical Treatment for Water Steam and Fuel

WESTERN CHEMICAL COMPANY

713 Washington Street Kansas City 5, Missouri

MAIL THIS COUPON TODAY

Western Chemical Company
713 Washington Street
Kansas City 5, Missouri

Send me full information about products checked.

1 2 3 4 5 6 7 8 9

Name

Firm

Address

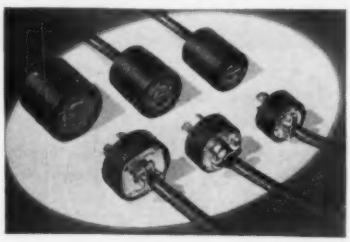
City Zone State

More EQUIPMENT NEWS

Begins on page 158

ity ranges from 1300 to 2200 lb condensate per hr. Except for built-in strainer, this unit is identical to the company's No. 812 side inlet, side outlet trap.

Armstrong Machine Works, Three Rivers, Mich.



Interlocking receptacles

768 • Interlocking receptacles and cord connectors feature *No-Trak* non-tracking, non-carbonizing molding material which will not break down under severe arcing, and will withstand flashover tests up to 5000 volts, according to manufacturer. Receptacles and connectors are available in 2, 3 and 4-wire types. The 2-wire devices are rated at 20 amps, 250 v, while the polarized 3 and 4-wire devices are rated at 20 amps, 250 v ac or dc, or 10 amps, 600 v ac. Full details available from manufacturer.

Arrow-Hart & Hegeman Electric Co, Hartford, Conn.

For more data on these items, use post cards p 167. Identify your request with item number

Power transformers

769 • Power transformers with ratings from ½ to 100 kva feature conservative design and material and workmanship in accordance with AIEE, NEMA and ASA specifications. Units are open dry-type design and available in single- and three-phase ratings. Full details obtainable on request to manufacturer.

Perkin Engineering Corp, 345 Kansas St, El Segundo, Calif.

Rubber-mounted bearings

770 • Sealmaster ball bearing units are now available in rubber mountings with pressed steel housings. Bearings are available as pillow blocks, flange and cartridge units in six shaft sizes ranging from ½ to

◀ Heat-treating and physical testing equipment shown at left is used for quality control of welding operators and for development of new welding procedures.

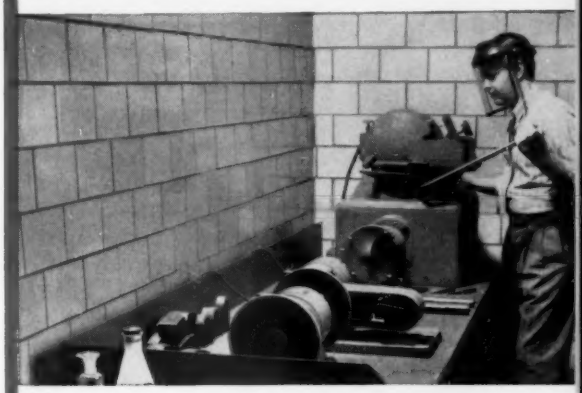
▲ This Rockwell hardness testing machine measures the hardness of weld specimens as a guide to proper procedures for heat-treating of welds.

Daily rigid testing is your insurance of quality welds in

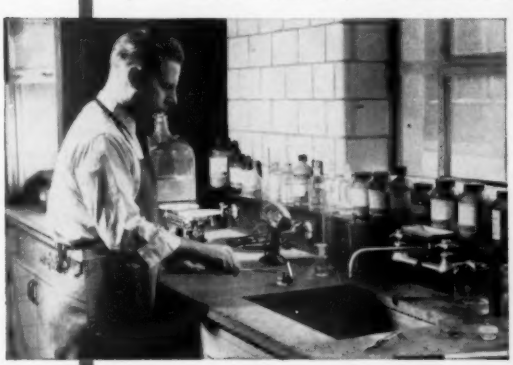
NAVCO FABRICATED PIPING

At Navco, a continuous parade of weld specimens are processed in the new, modern physical-chemical testing laboratory. It is here that weldments are studied metallographically and tested physically—all on a rigid schedule of quality control practices. Navco customers have benefited from progressive quality control practices for more than 40 years; they have come to know that piping installations, engineered, fabricated and erected by Navco, are precise, accurate and dependable.

Call on NAVCO for your next piping job.



▲ A laboratory technician cuts a sample from a pipe weld prior to grinding and polishing for metallographic examination.



▲ Here a weld specimen is etched to outline the grain structure for further metallographic study.

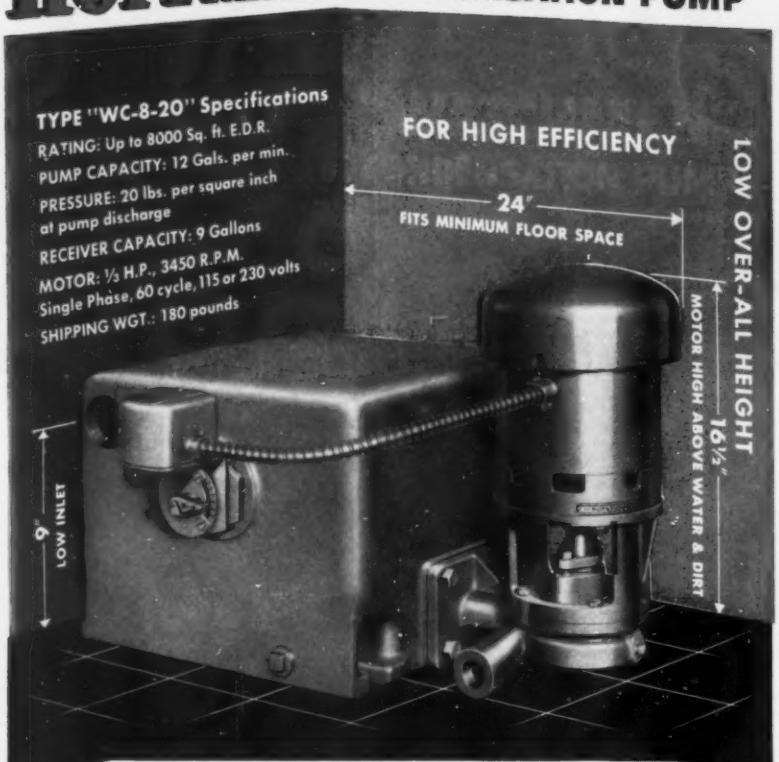
NAVCO

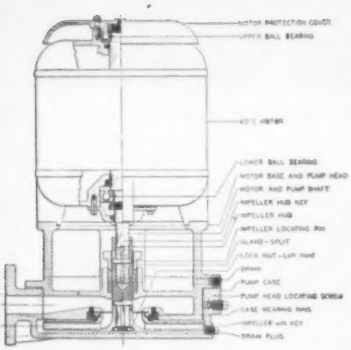
NATIONAL VALVE & MANUFACTURING COMPANY

3105 LIBERTY AVENUE, PITTSBURGH 1, PENNSYLVANIA

New York • Chicago • Cleveland • Boston • Atlanta • Buffalo • Cincinnati

HOFFMAN "WATCHMAN" CONDENSATION PUMP


TYPE "WC-8-20" Specifications
RATING: Up to 8000 Sq. ft. E.D.R.
PUMP CAPACITY: 12 Gals. per min.
PRESSURE: 20 lbs. per square inch at pump discharge
RECEIVER CAPACITY: 9 Gallons
MOTOR: ⅓ H.P., 3450 R.P.M. Single Phase, 60 cycle, 115 or 230 volts
SHIPPING WGT.: 180 pounds
FOR HIGH EFFICIENCY
24"
FITS MINIMUM FLOOR SPACE
LOW OVER-ALL HEIGHT
16½"
MOTOR HIGH ABOVE WATER & DIRT
9"
LOW INLET



This compact, highly efficient Condensation Pump is ideal as a replacement for old Boiler Return Trap installations. Immediate delivery can be made from stock. Ask your Wholesaler for full particulars with prices, or write for new Hoffman Condensation Pump Catalog CP-454, no obligation.

Here is a vertical, close coupled pump for low pressure heating systems, featuring:

1. One piece cast bronze centrifugal impeller dynamically balanced for smooth running and long life.
2. Receiver of heavy rust resistant cast iron.
3. All operating parts including motor and impeller assembly can be inspected or replaced without disturbing inlet or discharge piping.
4. Two-pole heavy duty float switch easily adjusted.

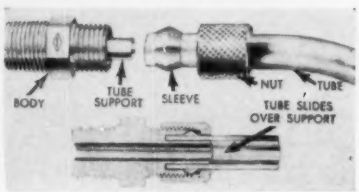
HOFFMAN SPECIALTY MFG. CORP. 1001 York St., Indianapolis 7, Ind.

Makers of Valves, Traps, Hot Water Heating Systems, Vacuum and Condensation Pumps . . . Sold by Leading Wholesalers of Heating and Plumbing Equipment

More EQUIPMENT NEWS

Begins on page 158

1 in. These units are designed for reduction of noise and vibration and are particularly suited to air-conditioning equipment and other light-duty applications. Housings provide maximum rigidity without sacrificing appearance and can be mounted easily with only two bolts. Full details available in manufacturer's bulletin 1253.
Stephens-Adamson Mfg Co, Sealmaster Div, Aurora, Illinois



Leakproof tube-fittings

734 • Tubing fittings that are hand tightened with a knurled nut are said to be leakproof and capable of withstanding severe vibration and major tube movement without loosening. They can be reused if desired.

Line comprises 16 different types of fittings available in several sizes.
Dekoron Products Div, Samuel Moore & Co, Mantua, Ohio

Non-corrosive soldering flux

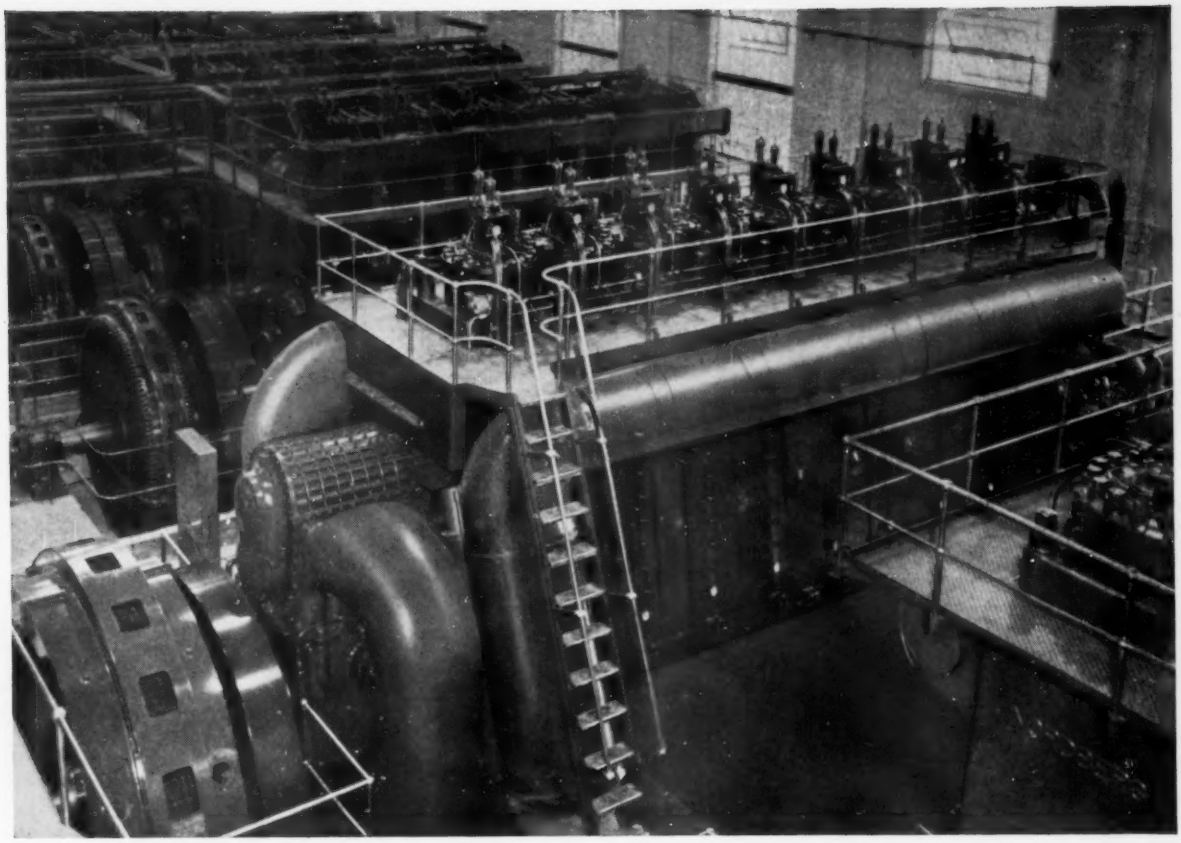
725 • No. 8 non-corrosive flux is for use on copper, brass, terne plate, tin plate, etc. Tests show No. 8 is fast enough to solder on clean steel without pretinning—a boon to anyone familiar with rosin and alcohol soldering.
Farrelloy Co, 1220 N 26th St, Philadelphia 21, Pa.

For more data on these items, use post cards p 167. Identify your request with item number.

Miniature clutches

708 • Miniature clutch series for overrunning, backstopping and indexing. Four models available with all features of full complement sprag principle. Manufacturer states the clutches have been standardized to meet industry's demand for small size clutches of high torque capacity, low price, long life and minimum maintenance. Standard bore sizes are ¼, ⅜, and ½-in.
Formsprag Co, 23601 Hoover Rd, Van Dyke, Mich.

(*Continued on page* 184)



Largest Diesel Power Generating Station in the U.S.

reduces cylinder and piston ring wear with SHELL ROTELLA OIL

Electric power for the City of Grand Haven, Michigan, and the surrounding area, is generated by diesel engines in the largest municipal power station of its kind in the U. S. A. Shell Rotella Oil is the cylinder lubricant.

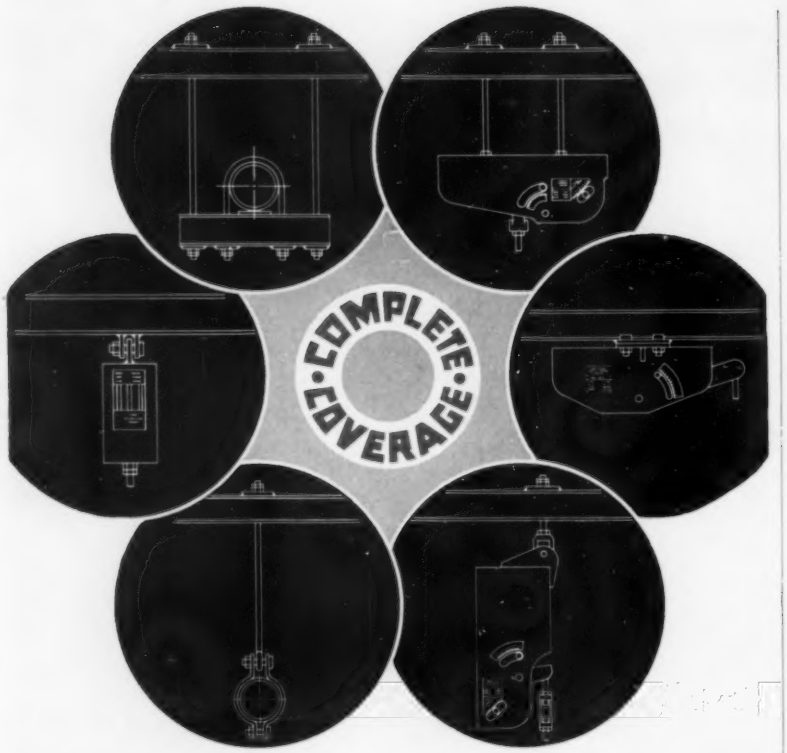
The anti-corrosive action in Shell Rotella Oil combats the major cause of engine wear . . . cylinder and piston ring wear caused by acid action from the by-products of incomplete combustion and condensation.

Tougher lubricating film in Shell Rotella Oil gives cylinders and rings greater protection . . . minimizes wear. Its effective detergent-dispersant action prevents harmful deposits.

Write for technical information. See for yourself how Shell Rotella Oil can help reduce your engine maintenance costs.

SHELL OIL COMPANY
50 WEST 50TH STREET, NEW YORK 20, NEW YORK
100 BUSH STREET, SAN FRANCISCO 6, CALIFORNIA

SHELL



B P

This is number 1 in a series of articles addressed to those engineers in the power and industrial fields who are responsible for the proper support of piping. This problem is ever-growing in importance and complexity as operating temperatures and pressures increase. As a result, Bergen Pipesupport Corp. is making this effort to explain and demonstrate some of the more popular types of pipe supports.

Our purpose is to help the designer, constructor, and operator understand the great variety of rigid and spring supports currently available. We hope you will find these brief explanations of sufficient value to warrant saving for future reference. Reprints may be had without obligation.

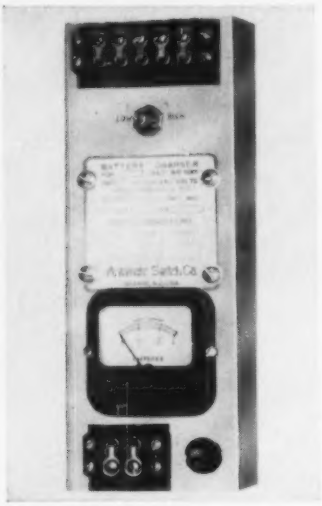
Our method is to illustrate and explain. Each future article will deal with one type of support. We shall strive to provide as much detail as space will permit regarding design, construction, operation, selection, and use of this equipment. The dominant theme will be simplicity and clarification.

Our background may be of interest. Bergen Pipesupport Corp. has many years experience in the design and manufacture of pipe supports. We specialize exclusively in this field. In addition to fabricating facilities, we offer a complete design service which has frequently been used for many of the largest central stations. Sales offices are located in principal cities throughout the United States. These offices are staffed by competent engineers anxious to be of every service.

BERGEN PIPESUPPORT CORP.
50 Church Street, New York 7, N. Y.

More EQUIPMENT NEWS

Begins on page 158



Battery charger

712 • Industrial type battery charger is designed for emergency generator sets and for general industrial use. When used with electric plant starting batteries, its purpose is to keep the starting battery of the emergency set at the properly charged level. Features, according to manufacturer, include: range of charging 0.05 to 2.0 amps; indicating built-in charging rate meter; input voltages 120 to 600; output voltages 6 to 32 dc; fully integrated unit in enclosure with selenium rectifier, transformer, rheostats and meter. Bulletin 203S will be mailed on request.

Automatic Switch Co, Orange, N. J.

For more data on these items, use post cards p 167. Identify your request with item number.

Molded pipe fitting insulation

743 • This molded insulation is made for rapid installation on hot and cold line fittings. Its limit is 450 F. The insulation is molded in halves to fit screwed and butt welded fittings. The two halves may be stapled, wired or taped.

Uniform thickness together with high insulating efficiency insures minimum heat loss. It will not settle, flake, chip, or crack, manufacturer claims.

Owens-Corning Fiberglas Corp, Toledo, Ohio

How to match your electrical system to production flexibility by:

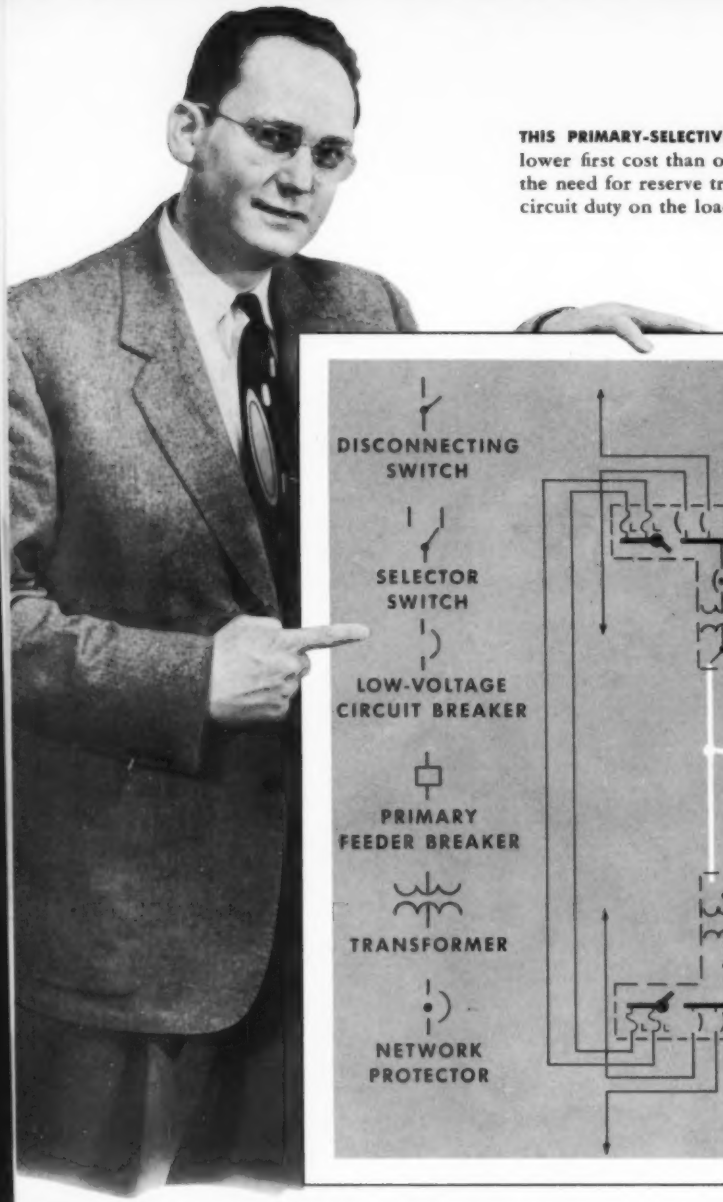
1. Engineering power distribution
2. Standardizing high voltage control
3. Getting power to the load quickly

Meet Joe Harris, Westinghouse Industry Engineering Manager, who presents some ideas on improving electrical system flexibility.

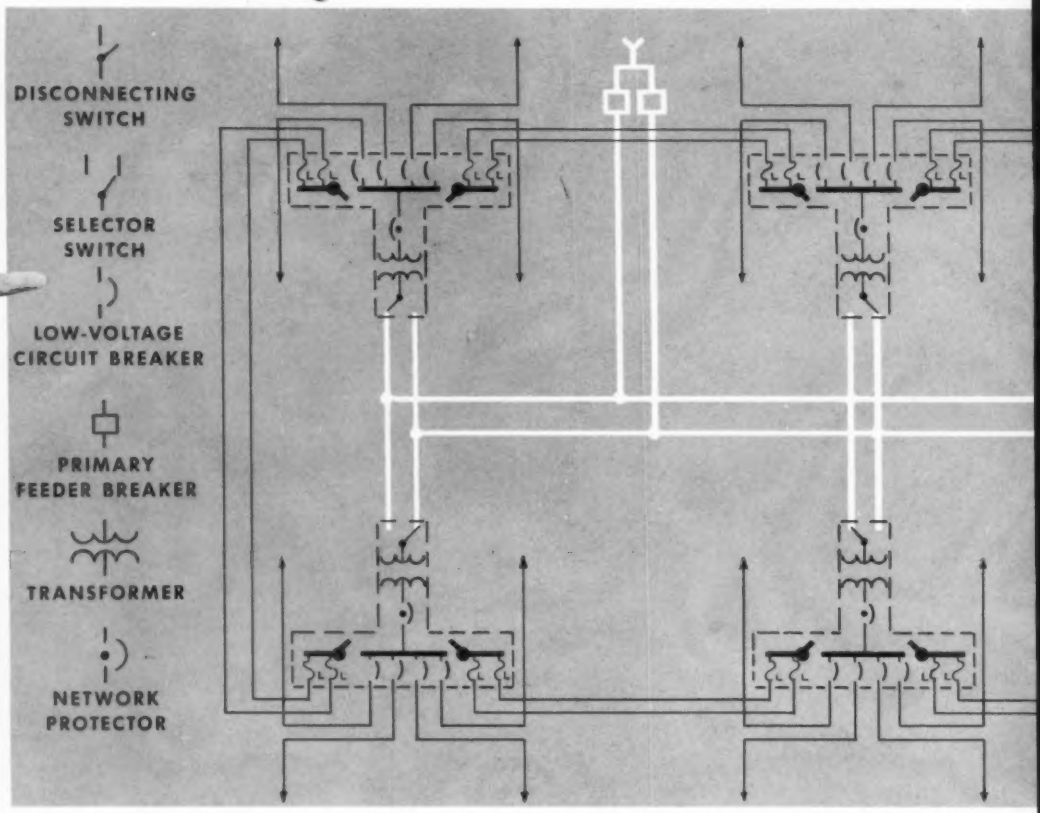
When you plan electrically for plant expansion or improvement, take advantage of Joe's wide experience in solving power distribution problems. It's part of the broad service your local Westinghouse representative offers in the talents of many design, engineering, and service specialists on the Westinghouse team.

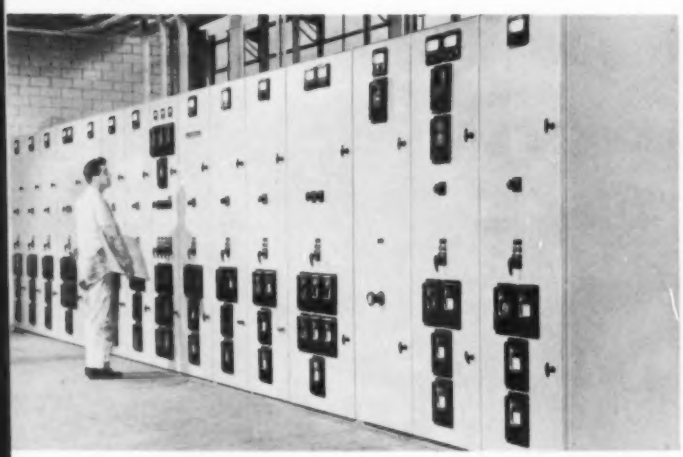
Next page, flexibility starts with engineered distribution . . . →

Page 1 of 8 in this section

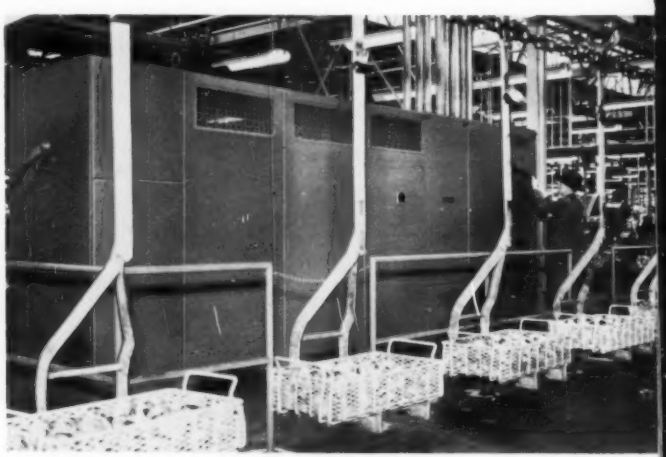


THIS PRIMARY-SELECTIVE NETWORK SYSTEM has the advantage of lower first cost than other types of networks because it reduces the need for reserve transformer capacity and reduces the short-circuit duty on the load circuit breakers.



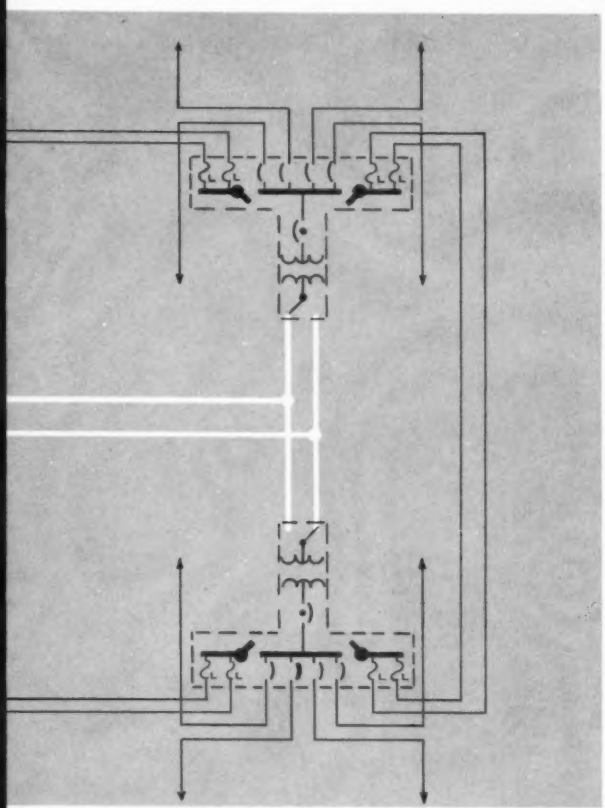


SWITCHGEAR IS EXPANDABLE in standard Westinghouse units. Standardized switchgear can be rearranged or relocated more easily to meet changes in future conditions. It also helps to speed maintenance and inspection.



HIGH VOLTAGE CLOSE TO THE LOAD is a cost-saving advantage you can achieve with Westinghouse power centers. They eliminate long, heavy secondary lines; save substantially on copper; lower line losses and improve voltage regulation.

Networks . . . one answer to flexibility, long-range planning



There are many excellent ways of distributing power in industrial plants. But if flexibility is your major requirement, you'll undoubtedly consider a network-type system. The slightly greater cost of a network system buys many immediate and long-term advantages. Network systems are easier to expand to handle increased power demands. Also this type of system is easily adapted to changing production needs which, in the long run, means economy.

Flexibility with this primary selective network system, for example, arises from the use of duplicate primary feeders—each capable of supplying the entire plant load. The feeder arrangement and the secondary-tie circuits permit the loads to divide among the power center, so that optimum voltage conditions are provided.

The ability to isolate any section of the system without disrupting service has obvious advantages. This permits maximum freedom in scheduling electrical maintenance or expansion, without disturbing operation of the plant. The network arrangement enables you to extend the system in any direction—at any time—with minimum rewiring and production loss.

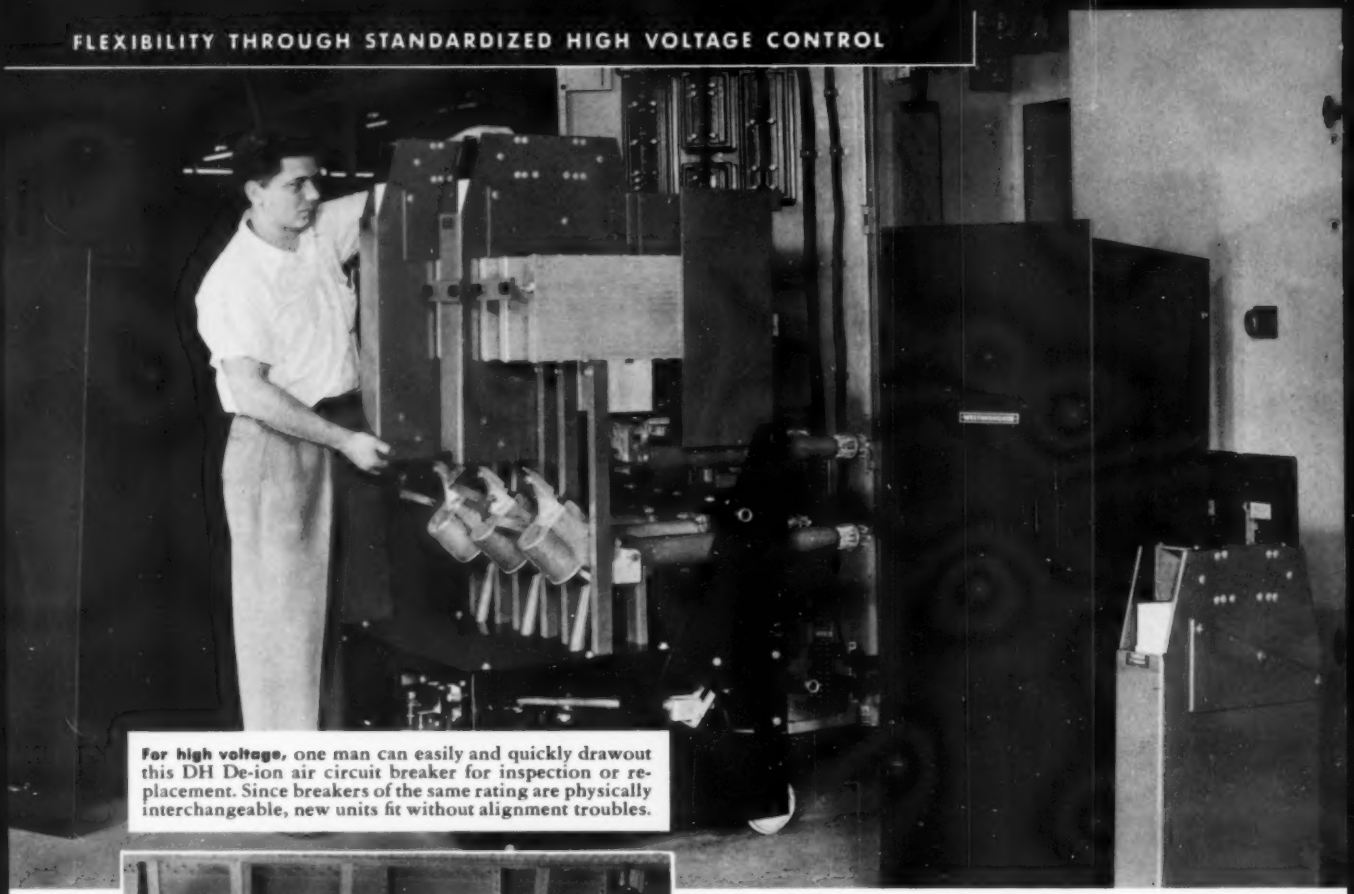
Through the coordinating ability of your Westinghouse representative, you can take advantage of the wide experience that Westinghouse offers in engineering flexible power distribution. Coordinating equipment planning, manufacture, shipment, installation and servicing are all a part of the power distribution job handled by your Westinghouse representative. Call on him for help at any time.

SPACE CONSERVATION is another advantage of Westinghouse dry-type power centers. You can install these compact lightweight Westinghouse units up out of the way of the working area—on balconies or roofs.

YOU CAN BE **SURE** . . . IF IT'S

Westinghouse

Standardized switchgear adds flexibility this way . . .



For high voltage, one man can easily and quickly drawout this DH De-ion air circuit breaker for inspection or replacement. Since breakers of the same rating are physically interchangeable, new units fit without alignment troubles.

Convenient expansion or relocation with standardized metal-enclosed switchgear

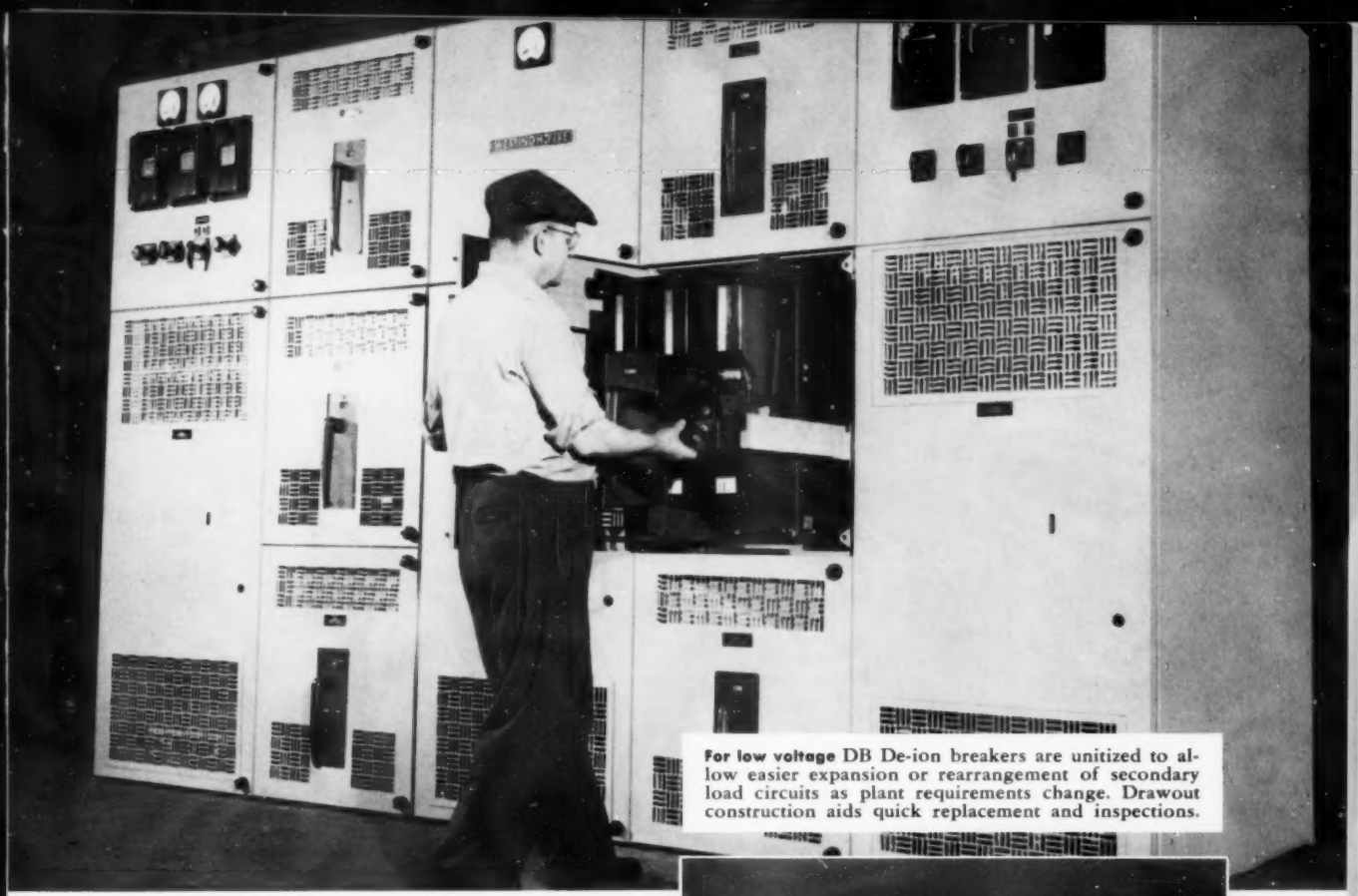
To achieve truly flexible power distribution you need equipment that is as flexible as the system itself. Nowhere is this more vital than in switchgear equipment . . . the heart of your plant's electrical control.

Westinghouse switchgear achieves flexibility through standardized frame design and manufacturing techniques. Here's what this standardization means to you:

Easy expansion or relocation A minimum number of basic units, each performing an important function, meets all the requirements normally demanded of

More flexibility per dollar is possible with Westinghouse high voltage metal-clad switchgear because all your money goes into equipment. Special engineering is held to a minimum in standard components that can be assembled in any combination required.

YOU CAN BE **SURE**...IF IT'S



For low voltage DB De-ion breakers are unitized to allow easier expansion or rearrangement of secondary load circuits as plant requirements change. Drawout construction aids quick replacement and inspections.

switchgear. Expansion in plant facilities is met by simply adding the required switchgear units. Production changes affecting switchgear are accommodated by substitution and rearrangement of units. And since all electrical equipment and connections are completely self-contained, entire installations can be picked up and reinstalled in another location or in another plant.

High voltage versatility Jig assembly of the breaker and stationary structure of high voltage metal-clad switchgear allows rearrangement of breaker units within the same structure. And since breakers of the same rating are interchangeable, conversion to a higher interrupting capacity can be accomplished with minimum expense.

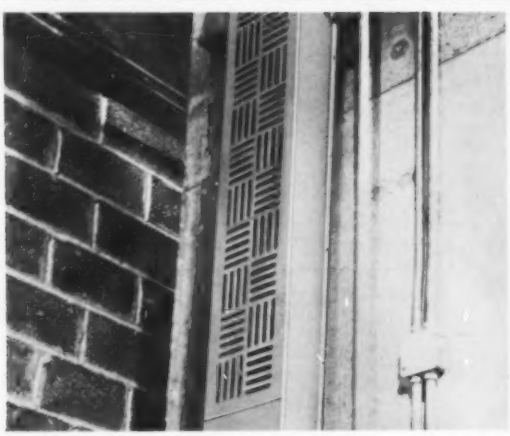
Low voltage service continuity Standardization means less production down time, too. Drawout, DB De-ion® breakers can be changed in three minutes flat. A spare breaker of the same rating can be substituted, and service continuity restored in short order.

Multi-purpose tripping provided only by Westinghouse low voltage DB De-ion air circuit breakers. Breakers allow delayed tripping on temporary overloads; trip on larger overloads before damage is done and trip instantly on short circuits.

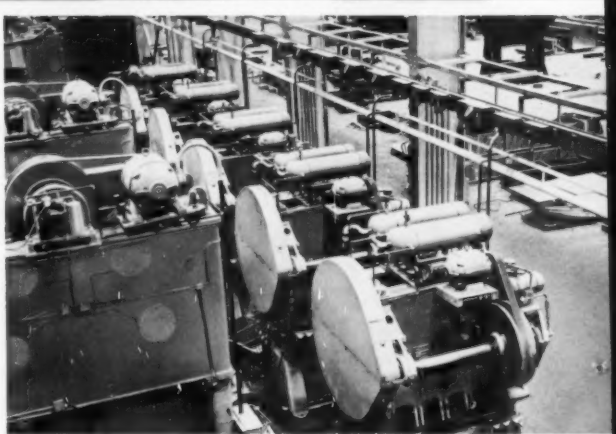
Next page, flexible equipment gets power to the load quickly . . . ⟶

Westinghouse

From switchgear . . . Power is fed directly to the plug-in duct mounted in convenient location. With drop rods in position, duct goes up in a hurry, slide cantilever hangers to position and tighten.



To branch runs . . . This 2000 ampere, low-impedance riser carries power to the upper floors. Note the use of spring suspension hangers which compensate for expansion of duct . . . allow simple installation.



To machines . . . Six power take-offs in six feet of Westinghouse bus duct spell power flexibility for any plant. Plug-in receptacles are provided for circuit breakers, safety switches, and cover-operated fusible units.

Bus duct meets changing load requirements easily

Where system flexibility really pays off is in getting power from switchgear to your production equipment. For this reason alone, bus duct is one of the best investments you can make in secondary distribution.

Unequaled flexibility—Power can be taken off plug-in duct at one-foot intervals for maximum convenience. Plants can be retooled, buildings revamped without rewiring because bus duct can be readily relocated and installed easily, around obstructions, in any layout.

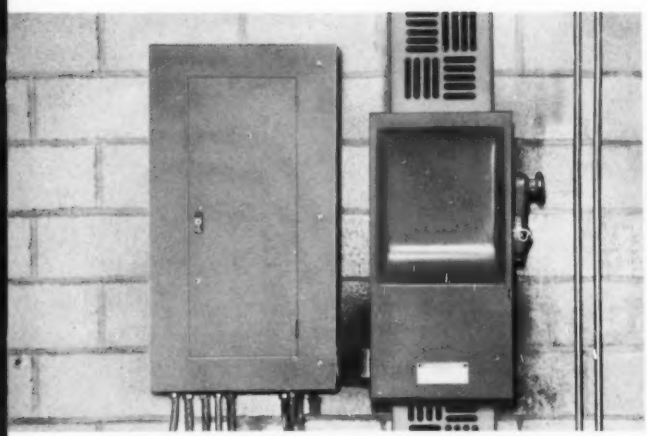
Costs less to install—Prefabricated in sections, bus duct goes in faster than cable and conduit. Savings in installation frequently reduce the original cost below that of any other secondary power distribution equipment.

Power for future loads—Bus duct spells future savings when building alterations and improvements add to power load. It provides important reserve capacity, and what's more, is readily salvageable, dismantled, reassembled, and expanded.

More power per dollar—Up to 5000 amperes, bus duct has greater current-carrying capacity, pound for pound, than any system of wireway or cable and conduit. There are four Westinghouse types: plug-in duct with service outlets for branch runs; low-impedance duct with low voltage drop for long feeder runs; weather-proof duct for outdoor installations that is available in feeder duct; and weatherproof duct in low-impedance duct.

YOU CAN BE **SURE**...IF IT'S

Westinghouse



To panelboards . . . Power is taken from plug-in duct. Additional circuits can be added with ease to Westinghouse Add-a-Circuit Panel, simply plug in the contact and wire up the terminals.

Control center expansion . . . Westinghouse control centers save frequently as much as 40% in installation costs over decentralized methods of mounting motor control. Saves time in inspecting control and reduces servicing problems.

Next page, how Westinghouse field engineering serves you . . . ——→

Westinghouse field service adds a working partner to your team . . .

Westinghouse field engineers are trained to know product and industry problems. When you call on their application know-how, they become a working partner to your engineering and manufacturing personnel, consulting engineers and contractors. It removes your engineering staff from detailed planning.

Simplifies ordering problems . . . Westinghouse coordinates all manufacturing and shipping schedules to deliver matched equipment to the job at the right time. Fast delivery of genuine Westinghouse renewal parts from stock in 31 locations enables you to reduce parts inventories at your plant.

. . . and helps maintain power system flexibility

Thirty-eight large, well-equipped Manufacturing and Repair Plants are available to you for maintenance jobs on all types of electrical apparatus. These apparatus repair plants are spotted in key industrial areas to provide factory-type repairs at a local level.

* * * *

For further information on the products or services discussed in this section or for a copy of the literature listed here, call your local Westinghouse representative, or write Westinghouse Electric Corporation, 3 Gateway Center, P. O. Box 868, Pittsburgh 30, Pa.

Ask For . . .

High-Voltage, Metal-Clad Switchgear	B-5306
Low Voltage, Metal-Enclosed Switchgear	B-5282
Dry-type Transformers	B-5920
Bus Duct	B-5835
AB-I Circuit Breakers	B-5456
Safety Switches	B-5457
Panelboard Planning	B-5260A
Control Centers	B-5621
Capacitors	B-3966A
Current Limiting Reactors	B-5918
Preventive Maintenance Booklet	B-5477

. . . and ask for a showing of the 20-minute film "Selecting The Right Industrial Distribution System".

56 Field Engineering Service Offices help speed completion of power system engineering, installation or modernization. Skilled Westinghouse engineers work with your personnel to coordinate product application.

Field Service Engineers are always ready to make quick inspections, adjustments and on-the-spot repairs for equipment that cannot be moved easily to one of thirty-eight Westinghouse Manufacturing and Repair Plants. MP-3014

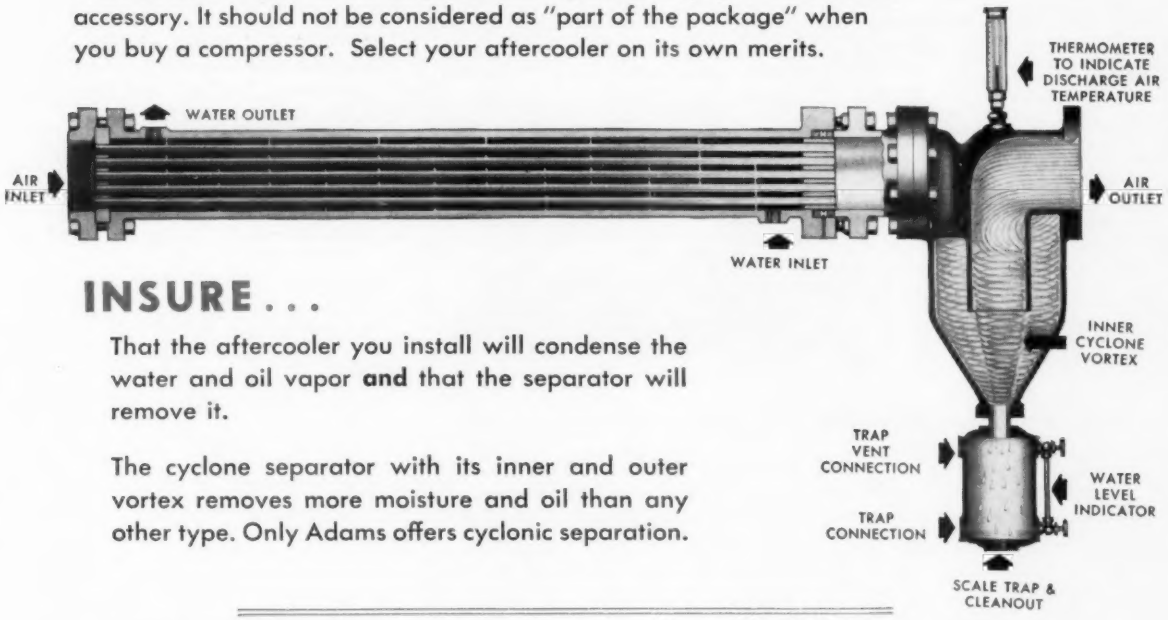
YOU CAN BE SURE...IF IT'S Westinghouse

LOSING MONEY ON WET, DIRTY AIR?

Rx ...SEE A SPECIALIST!

Removal of moisture from compressed air is a problem entirely independent from the type of compressor used. It is a problem for **specialists** in the design and manufacture of aftercoolers. Specialists for nearly two decades, the R. P. Adams Co. has built a solid reputation on the aftercooler and cyclone separator that are chosen throughout industry for better performance, price and delivery.

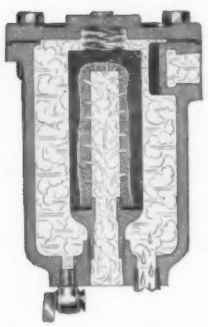
The aftercooler you install to protect air operated equipment is not an accessory. It should not be considered as "part of the package" when you buy a compressor. Select your aftercooler on its own merits.



INSURE...

That the aftercooler you install will condense the water and oil vapor **and** that the separator will remove it.

The cyclone separator with its inner and outer vortex removes more moisture and oil than any other type. Only Adams offers cyclonic separation.



ADAMS PORO-STONE AIR FILTER

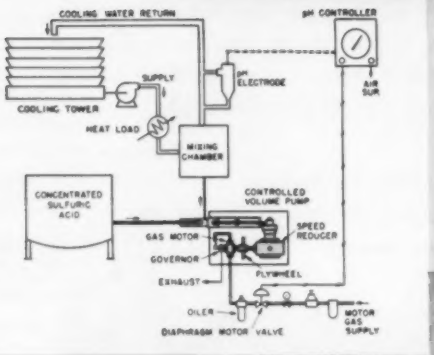
Why Adams Poro-Stone Air Filters are Famous

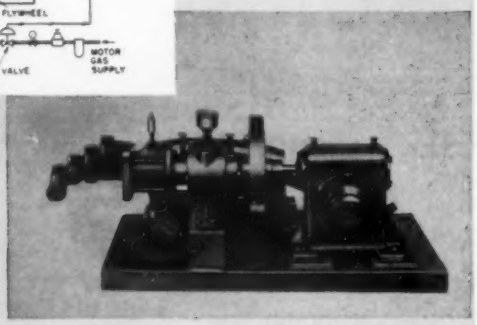
1. Rapid diffusion and filtration through permanent, cleanable Poro-Stone.
2. Centrifugal separation of dirt and liquids.
3. Drainage to trap directed by cast-in slots.
4. Continuous, fully automatic trap action.
5. Easily installed in vertical or horizontal pipeline.
6. Less than ½ lb. pressure loss at rated capacity.

SEND FOR BULLETIN 177 TO:

R. P. ADAMS CO., INC. 211 EAST PARK DRIVE BUFFALO 17, N. Y.

CONTROLLED VOLUME PUMPS ARE FLOW-CONTROL INSTRUMENTS





Here's how close pH control helps extend cooling tower life

As final control elements in automatic pH control systems, Milton Roy Controlled Volume Pumps solve a basic low-capacity flow control problem. In the system shown, for instance, these pumps meter 98% sulfuric acid to cooling tower water automatically on demand. Optimum pH control is assured, minimizing chemical or biological attack and delignification of the wood of the cooling tower.

Other applications in water treatment include systems for internal or external treating, for scale and corrosion prevention, precipitation of salts, removal of dissolved oxygen.

See how Milton Roy Controlled Volume Pumps can solve *your* low-capacity flow control problems. Milton Roy's engineering service includes —at no extra cost—proper instrumentation, panelboard design, sizing of equipment and all other engineering details.

Engineering Representatives in the United States, Canada, Mexico, Europe, Asia, South America and Africa

MILTON Roy COMPANY

Manufacturing Engineers 1305 E. MERMAID LANE • PHILA. 18, PA.

CONTROLLED VOLUME PUMPS AND AUTOMATIC CHEMICAL FEED SYSTEMS

More Plant Problems

Begins on page 134

Replacing lamps

Continued from page 136

REPLACE lights in difficult areas during the night or at other periods when the work will not interfere with plant production. Lamps may be replaced whenever 20% of those in an area have failed. But if the light is insufficient, replace lamps after 10 or 15% burn out.

Use a good reset starter to reduce flicker in failing tubes. Clean reflector and fixture when replacing a tube. Group replacement does not pay where single tubes are easily replaced without production losses. But if production losses will occur, then group replacement will prove to be a money-saver.

JAMES SMITHWICK
Washington, D. C.

ANNUAL replacement of lamps on a weekend is the most economical method. Use a portable platform of the correct height to help speed the work.

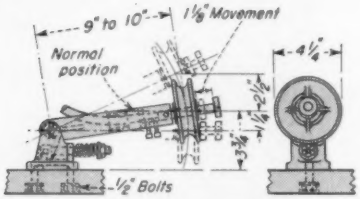
MELVIN EVANS
Minneapolis, Minn.

SOLID-MOUNTED lamps seem to have a much shorter life when subjected to excessive vibration. It is good practice to replace lamps when they begin to darken at the ends. Lighting efficiency falls off rapidly as condition worsens.

A M DAMEROW *Elk River, Minn.*

Keep static off belts

Continued from page 138



TROLLEY-WHEEL collector, *in sketch*, works well and can be used as a tension-adjusting idler. Machine wheel to fit belt contour. For multiple belts, fit one wheel for each belt.

L C VAN HUBEN *Orangeburg, N. Y.*

INSTALL PUMP in a small house as far from the main building as possible. House need not be heated because gasoline will not freeze at ordinary temperatures. Fit a roof ventilator to allow gas fumes to escape. Such an installation has lower insurance costs.

Be sure this work conforms with Code requirements because handling gasoline is considered hazardous.

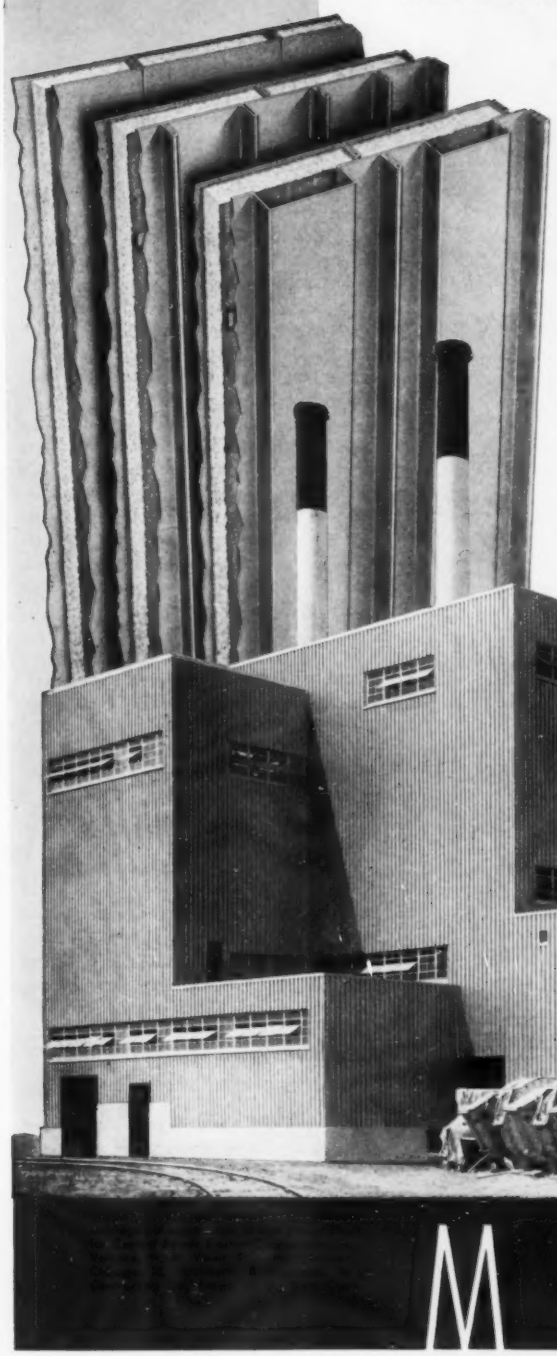
ART BELTON *Montreal, Canada*

(*Continued on page* 196)

INSULATED METAL WALLS

for POWER and STEAM GENERATING PLANTS

ALUMINUM, STAINLESS or GALVANIZED STEEL



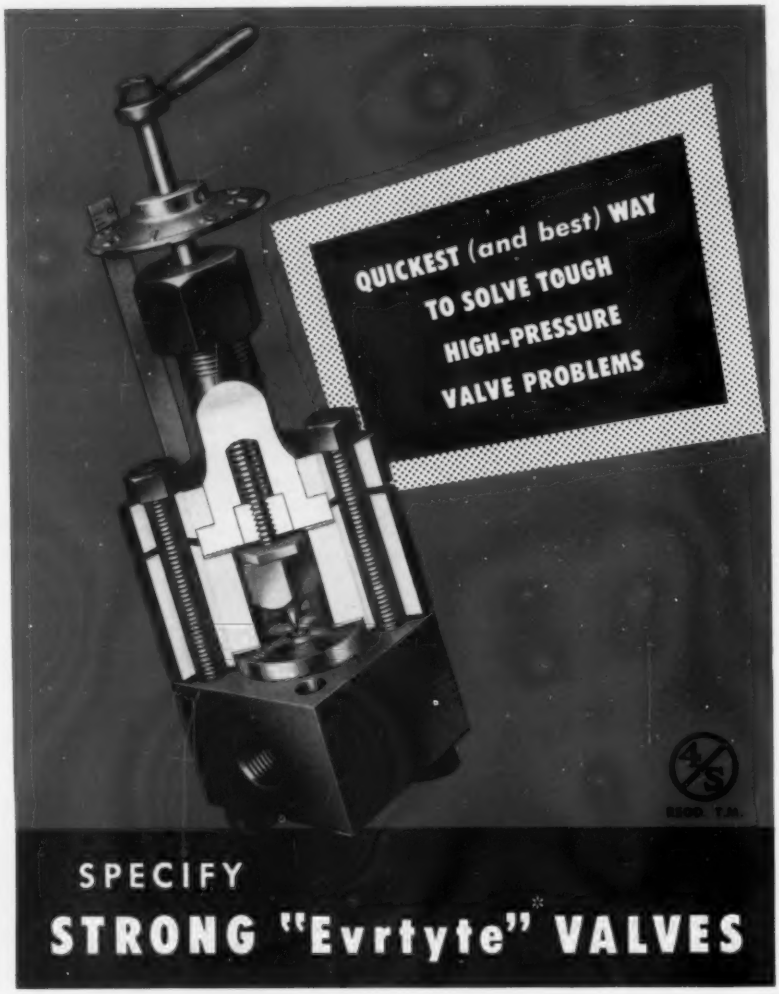
The Power Generating Plant illustrated below, and thirty-one other power and steam generating plants constructed to date with Mahon Insulated Metal Walls, is convincing evidence of the current trend in housing modern power generating equipment. In this particular plant, all exterior wall surfaces are Stainless Steel . . . strikingly attractive, permanent material which requires no maintenance whatsoever. Mahon Insulated Metal Walls are available in the three distinct exterior patterns shown at left. Mahon "Field Constructed" Fluted or Ribbed Walls can be erected up to sixty feet in height without horizontal joints—a feature of Mahon Walls which is particularly desirable in powerhouses and other buildings where high expanses of unbroken exterior wall surface are common. Thermal properties of Mahon Insulated Metal Walls are excellent . . . over-all "U" Factor is superior to that of a conventional sixteen inch masonry wall. See Sweet's Files for complete information including details and Specifications, or write for Catalog No. B-54-B.

THE R. C. MAHON COMPANY

Detroit 34, Mich. • Chicago 4, Ill. • Representatives in All Principal Cities

Manufacturers of Insulated Metal Walls and Wall Panels; Steel Deck for Roofs, Partitions and Permanent Concrete Floor Forms; Rolling Steel Doors, Grilles and Underwriters' Labeled Rolling Steel Doors and Fire Shutters.

MAHON



SPECIFY

STRONG "Evrtyte"* VALVES

Here's a block steel valve that has established a reputation for exceptional handling of "the toughest valve job in the plant"—continuous boiler blowdown at pressures up to 1800 psi and temperatures to 800° F.

Advanced design and construction features provide many exclusive advantages in accurate flow regulation under severe conditions—plus an operating life which in some cases has proved to be *ten times* that of other valves used before Evrtyte!

This great valve is equally effective on many other steam and hydraulic "tough" valve applications and it could very well solve your problem where other valves have failed in control service.

Write today for full information or contact your local STRONG distributor.

* REGD. T.M.

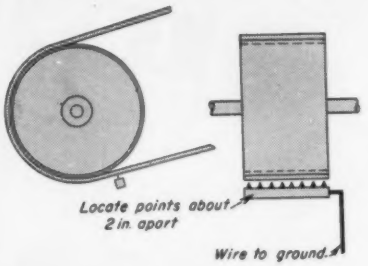
STRONG

STRONG, CARLISLE & HAMMOND

1392 WEST 3rd STREET • CLEVELAND 13, OHIO

More PLANT PROBLEMS

Begins on page 134



THOROUGHLY VENTILATE all gas-ridden areas—this is the best explosion preventive. Providing enough air to dilute the gas greatly minimizes the dangers of explosion. Static discharges are dangerous if an explosive mixture of air and gas is present.

In the old days when wide leather belts were used, the crew often objected to the wallops static would give them. So a series of steel or copper points were often arranged as shown in the sketch. Bar is grounded solidly to some convenient place in the plant.

Arrange the points so they are opposite some spot where the belt runs smoothly and steadily. Mount the points as closely as possible to the belt. This reduces spark size, eliminating the hazard to a greater extent than if the spark had to jump a large gap. But no matter what method is used to reduce static, be sure you thoroughly ventilate the area where the pump is housed.

H B McDERMID *Long Beach, Calif.*

MAKE A COMB of spring brass or beryllium copper with teeth 4 to 6 in. long. Keep comb points close to belt in a region where there is no belt flap. I've used combs successfully in toluene plants where explosive limits range 1.3 to 6.8%, as compared with 1.4 to 6.0% for gasoline.

IRA A BUTCHER *Cincinnati, O.*

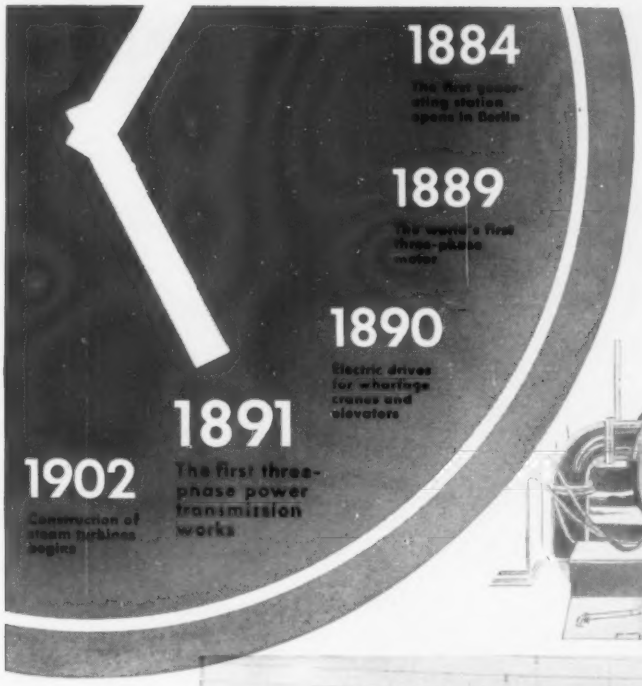
SUSPEND TINSEL from the metal guard over the pump and motor sheaves. Ground both machines to the building grounding system. Be sure both sheaves are conductors. Check ground conductors to see they are in good condition.

OBENO CUOGHI *Richmond Hill, N. Y.*

DON'T GROUND belts if both pulleys are metal and the pump and motor have duplicate grounds. Remember to ground both ends of any rubber hose through which gasoline is pumped. Use vapor-tight equipment for pumping both the motor and its controls .

JAMES SMITHWICK *Washington, D. C.*

(*Continued on page* 198)



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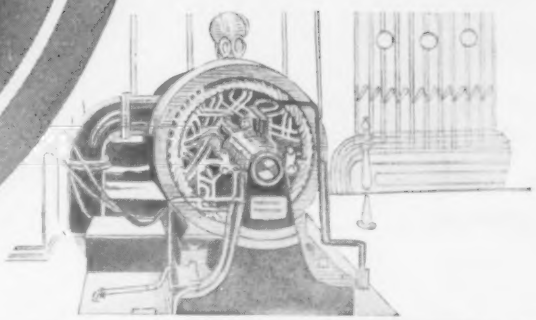
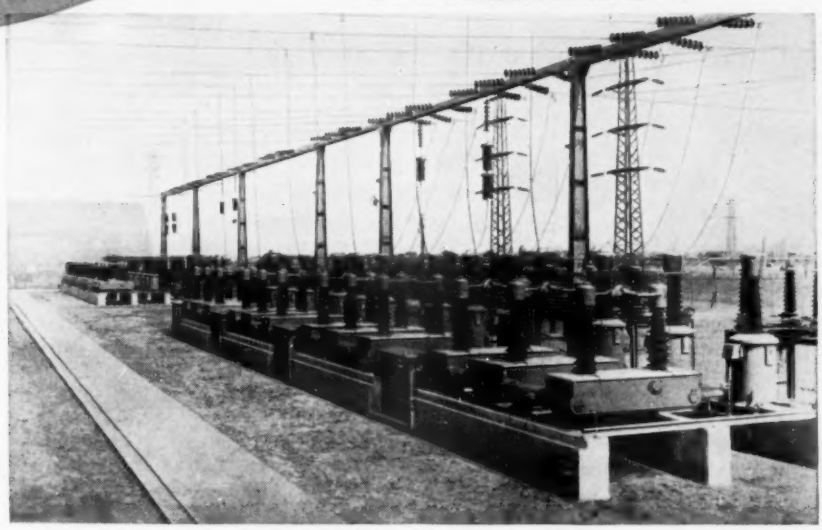
and the first hours of Electrical Engineering





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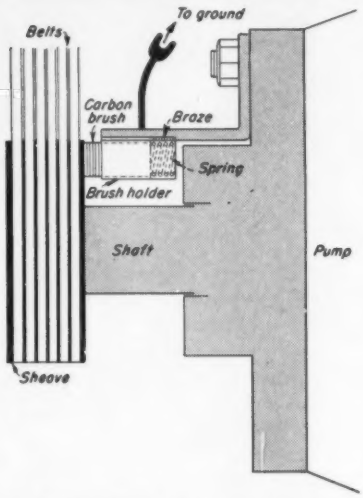
More Plant Problems

Begins on page 134



CARBON BRUSH riding on either sheave, *sketch*, will collect many charges that build up on the belts. Use a good, clean ground connection. Provide a safety factor by using two brushes since one may crack or wear out. Hard carbon has negligible wear.

CLIFFORD F BISHOP *Fredonia, N. Y.*

Other readers sending good answers, for which we lacked space, are:

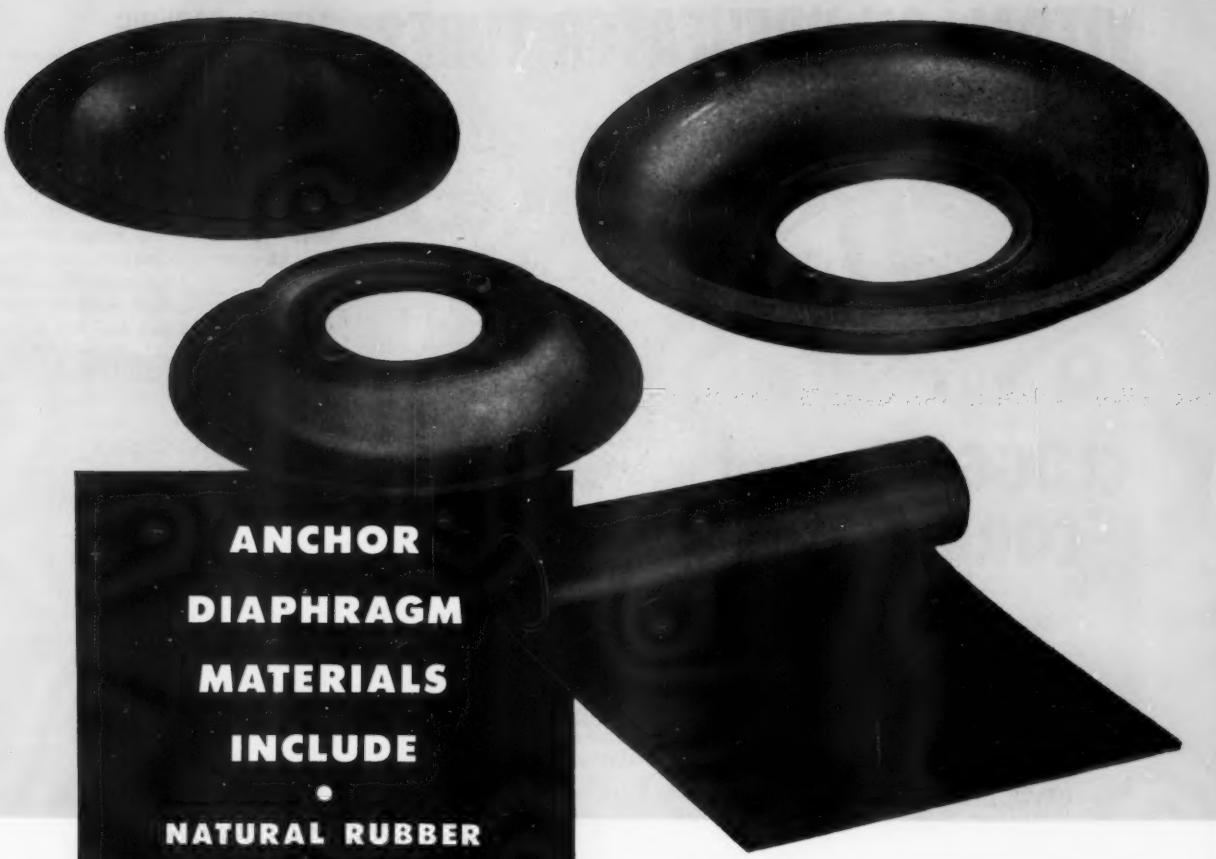
H A KAISER *Glendale, N. Y.*
A A HUNNEWINKEL *Woodstock, Ill.*
HOWARD HOLCOMBE *Los Alamos, N. M.*
MELVIN EVANS *Minneapolis, Minn.*
N M TURITZIN *Whitestone, N. Y.*
C O VON DANNENBERG *Brooklyn, N. Y.*

REFRIGERATION

Continued from page 127

ment, the only purpose of the water is to keep the refrigerant-coil surface wet. Water doesn't have to carry its heat to a separate cooling tower. Operation is, therefore, possible with relatively small amounts of water, smaller pump and piping system, and lower pumping-power cost. Also, the combined unit requires less space than a cooling-tower installation. So it is generally selected in the lower range of refrigeration tonnages, although some operators justify its use in relatively large units.

Piping diagram on p 127 shows hookup of the evaporative condenser and how it ties in with refrigerant piping. Subcooling coil helps prevent flashing of refrigerant before inlet to expansion valve. Valves, fittings and instruments shown follow much the same pattern already discussed under the heading of cooling towers.



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CARBON PACKING

Continued from page 123

ring spacers. Lip also allowed ring to be assembled in open. No lip is needed when used with solid spacers.

Don't use angle-type ring in diaphragms of a flexible-shaft machine as they don't give enough when going through critical speed. Rings have been used on steam and exhaust ends of such turbines where amplitude of vibration is not so large. They work very well on stiff-shaft turbines and are so used by several firms.

Turbine makers always looked for a better carbon-ring spring material. When Inconel was brought out it worked much better than monel. All turbine firms changed to this material for their packing springs. Springs are heat-treated to around 700 F to lessen chances of taking a permanent set before they reach this temperature in turbine.

Stainless-steel packing springs were tried, but they were not satisfactory. Whether fault was way springs were manufactured or something in steam that caused trouble, I didn't know. Springs returned for our inspection were so brittle you could crumble them with your fingers.

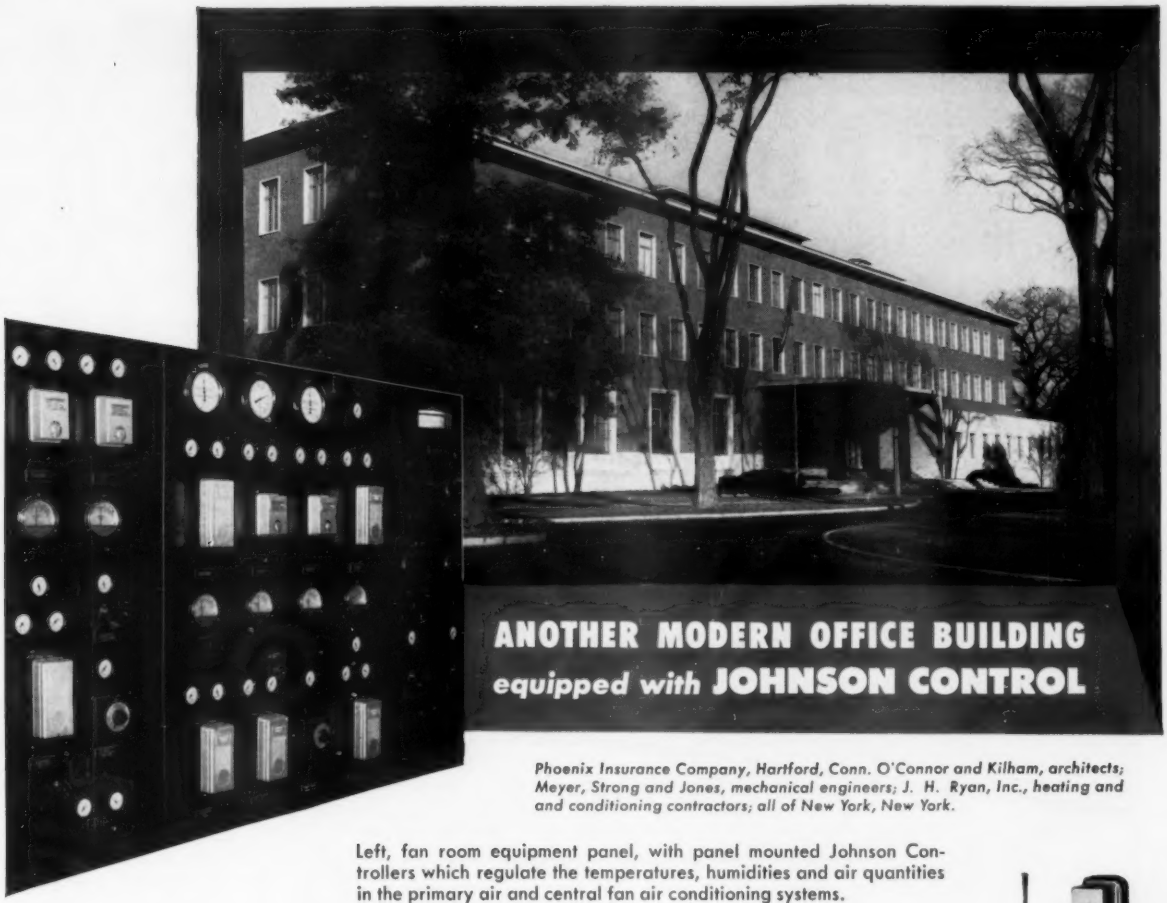
Turbine shaft under carbon glands always wear from carbon rings. To solve problem, one company sprays monel on surface under glands. Others spray with hard stainless steel or with hard chromium. We finally settled on hard stainless steel for our shafts. This was a break for carbon glands, just as the noncorrosive packing spacers were. If a turbine is shut down for any time, shaft and packing gland start to rust. Rust is an abrasive and when turbine is again started, rust wears carbon rings and shaft.

This brings me to the last carbon-packing design I made a short time before retiring. Whether it will ever be used, I do not know. My idea is a combination of angle-type ring and solid spacers with an improved carbon-ring stop.

Original gland had spacers centered in bore of packing case by a lip on spacer. In new design they are centered in groove. This eliminates a machining operation on spacer. Asbestos packing is in bottom of groove, not as wide as groove to allow room for crushing. Soft packing not only helps make a steam-tight joint, but with friction at side walls of grooves, it also keeps spacer from turning.

Packing stop originally in packing case has been removed from case and put on spacer. This removed it from a large piece and put it on a small piece easy to handle, machine, assemble.

In packing ring I gave the assembly



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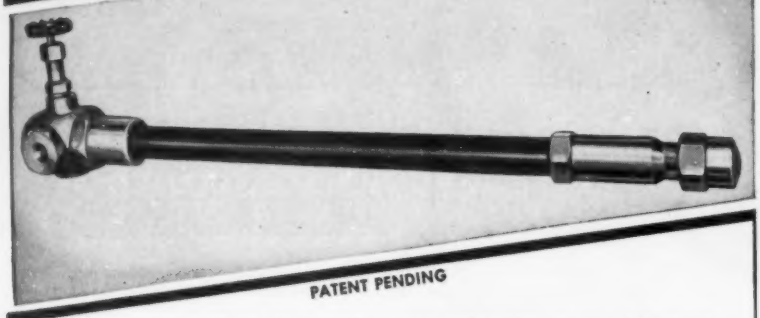

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CARBON PACKING

Continued from page 200

man and operating engineer a break. Sales department also has a talking point, but management will probably kick, as ring costs more. Place is usually cut for stop on one end of segment. I placed slot at one of butt joints so it takes in two segments. Because angle-type ring has slot so located, it can only be assembled one way. You don't have to stop and look for markings on segments when assembling.

Look at a used carbon ring. You usually find that segment next to stop is worn out of round. This is caused by slot's surface or packing stop not being radial. Both surfaces should be radial for best results. By looking at second sketch, you see what would happen if one side were radial and the other parallel to radial side. The smaller the ring, the worse the condition. The thicker the stop, the worse it gets.

In experimental packing case we made packing stop of shape to match shape of stop slot with its radial sides. This required specially shaped material and stop had to be located with a fixture before riveting in place. I decided that with all care needed to locate stop, a small error would throw the surfaces out. Here's how this trouble can be eliminated. A pin is riveted to spacer. Place a piece of square stock on this with an axial hole in center. Rivet end of pin over enough to keep it from coming off, but allow it to turn. This allows stop to turn, thus conforming to surface of slot in carbon ring even if there's a slight error in location.

Some designers probably won't agree with above stop, as other type carbon-ring stop has given good service. But I always remember what the chief engineer of a large firm told me in 1910. I asked why the Navy rated their destroyers highest. He thought it was because the details were well thought out and taken care of. Some of the other shipyards didn't think details so essential.

When assembling packing in a turbine, stops must be set about on horizontal split of packing case, or above it. Otherwise, when top half of packing case is raised, packing rings may be damaged. Reason is that spacers may stick in top half and be lifted as far as their shaft clearance allows. To stop having less clearance between it and ring will break ends of segment.

Packing that you have to replace by removing top half of turbine case gives you maximum number of rings in minimum space. It was originally built with one leakoff ring and three active rings for 50-psi backpressure. After trying out on test floor it performed

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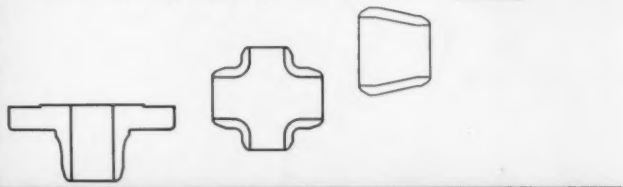

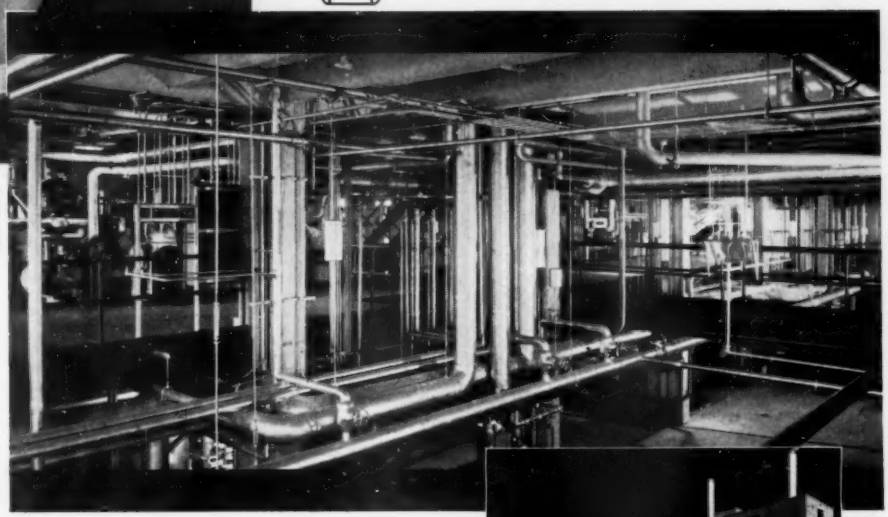

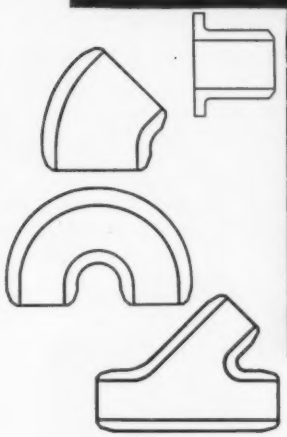

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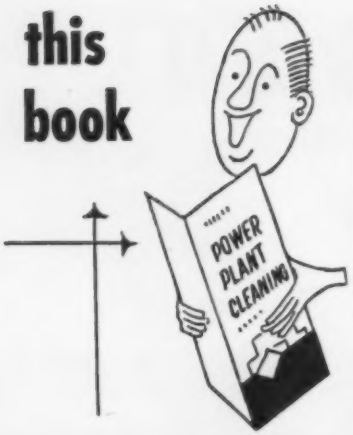

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CARBON PACKING

Continued from page 202

very well. Then NEMA changed standard for that class of turbine to 75 psi backpressure, which meant adding another carbon ring for good service.

Next advance, for a single-stage turbine, will be to put the same amount of carbon packing in the same space, and yet be able to remove it easily without lifting turbine cover. Some clever designer will probably figure this out one of these days.

SUPERPRESSURE

Continued from page 95

should such pumps run? 4000, 5000, 7200 or 10,000 rpm?

Pump drive. The pump problem cannot be considered without analyzing the pump drive. If we want speeds higher than 3600 rpm, how will we get above the 60-cycle limitation? A speed-increasing gear would serve with a 2-pole motor. This introduces an element of inefficiency and added maintenance. Variations in output preclude using a constant-speed pump with throttling of excess pressure.

What about variable-speed operation? The service looks attractive for a steam turbine because of sustained internal turbine efficiency over a wide operating range. Good turbine efficiency would be expected at the large pumping power needed. On the other hand, where will we get the steam? Even a large auxiliary turbine would be too small to accommodate supercritical pressures. Wouldn't the steam have to come from a lower-pressure source, such as a boiler or extraction point in the main unit? The latter poses problems that might be avoided with some other kind of drive.

The gas turbine has merit in high and variable speeds, but its limitations to gas and oil fuels is a drawback. The diesel engine might be adapted, but the stepup gear ratio would be high even for so-called "high-speed" diesels.

Doesn't this drive us back to the electric motor with its speed-variation limitations? An hydraulic coupling might answer, but wouldn't it have to be placed between motor and gearbox because of the high speeds? Couldn't we take advantage of some proven methods in the marine field? Electric-drive ships use main propelling turbines for frequency control. Couldn't we adapt a house unit to similar service? An operable arrangement using higher frequencies could be developed. No divine guidance sets 60 cycles as the limit. Why can't a higher frequency be chosen?

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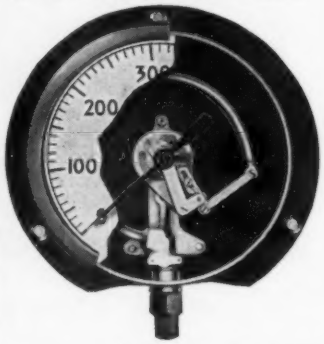

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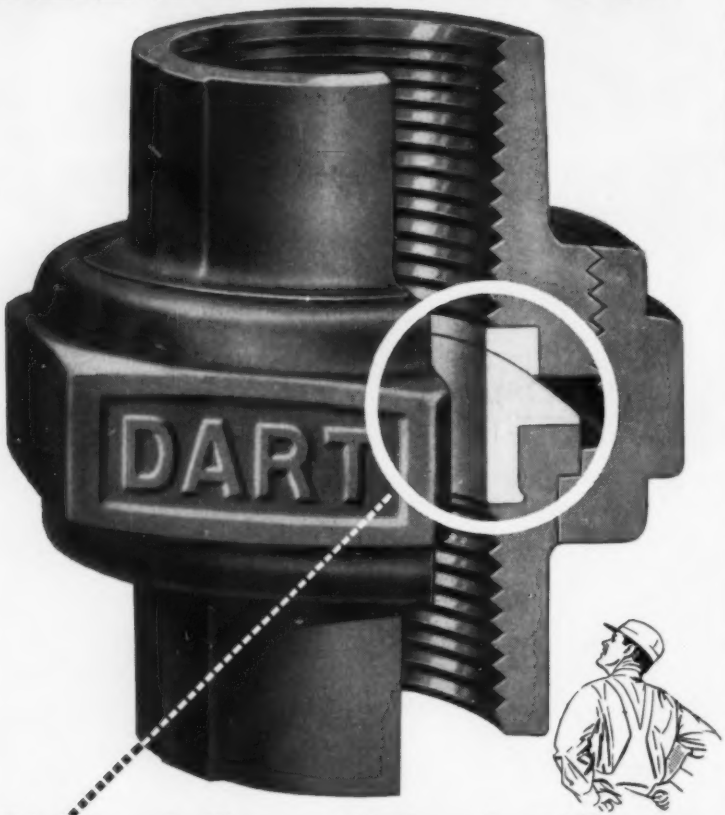

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SUPERPRESSURE

Continued from page 204

once-through "boiler" is radically different from the conventional boiler in the requirement imposed on the feedwater quality. Standard practice delivers steam with solid contaminant concentrations of less than one part per million from boiler water containing solids as high as 2000 ppm. Steam purity can be maintained by blowing down the boiler.

In the once-through "boiler," however, what goes into the boiler with the feed must come out the steam line. There is no opportunity for concentration and removal in the boiler water. What steps must be taken to meet specifications on steam purity? Somewhere in steam-making equipment the solids must turn to dust and a deposit is bound to form on the tubes in that region. How will the tubes be protected from overheating at such points? If deposits form, how will they be removed?

Condensers. If solids come over in the steam from the "boiler" will they deposit on the turbine blades at selected stages, or will some of the contaminants get through to the condenser and deposit on the condenser surface? If this does happen, will not provision have to be made to clean the steam side of condenser tubes? This could introduce a new problem.

If only clean steam reaches the condenser, new problems will still be present. Suppose a leak develops at a rolled tube joint, or suppose a tube splits, what features will avoid contamination of much of the feed supply? Perhaps the worst condition would be with sea water where the old rule of 500 to 1000 lb of blowdown for each pound of inleakage can no longer apply. Should we use double tubes, sectionalized shells, double tube sheets, or what? Some new thinking will be helpful in this area.

Controls. Instrumentation and control must be greatly different on a super-critical installation because of the once-through forced-circulation feature. Changes in steam demand require instantaneous response from the feed pumps. Perhaps a more important control problem will be protection of the fired heating surface including the reheaters. Metals for these parts are in high-temperature zones, and during starting, stopping and emergency tripouts the service requirements can become very severe. Reducing valves, desuperheaters, spill-over arrangements would all need consideration as protective measures.

Feed heating. What form will feedwater heaters take? There will be alternatives of pumping hot or relatively cold feedwater. To take advantage of

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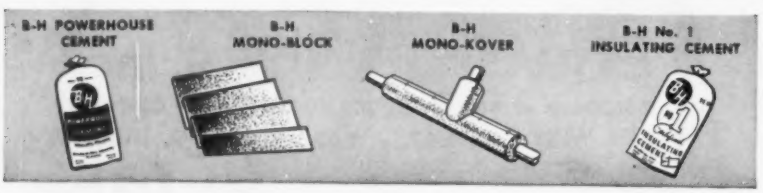


SUPERPRESSURE

Continued from page 206

lesser power need for cold-water pumping some heaters would have to follow the pump discharge. These heaters could require very heavy parts, being in the highest pressure part of the cycle.

Sectionalizing valves and piping could pose disturbing problems. Alternatives might be to (1) pump hot water at reduced economy (2) split pumping duty between two units or two elements of a single unit. With the latter arrangement, pump control through variable speed can be troublesome. A variable-speed booster pump would require a large range to accommodate demands for variations in head and capacity. If two pumps are placed on a common shaft, or if two elements are combined in a single casing, then we have an internal-design problem to handle two water temperatures, 100 to 200 F apart, on the same pump. Such an operating condition is not to be treated lightly.

Many operators have had unfortunate experiences with pumps when subjected to wide temperature differences or rapidly changing temperatures. Aren't these the problems, because we know how to pump hot or cold water? Rapid temperature changes are often our undoing.

Industrial power. Too many people are inclined to take a narrow view of the term "power." They think of it as synonymous with electric power. They fail to appreciate the vast demands for power from manufacturing establishments. Here requirements for process and building heat are best met by so-called byproduct power plants, those passing high-pressure steam through a turbine before exhausting it to process-steam mains at an appropriate pressure.

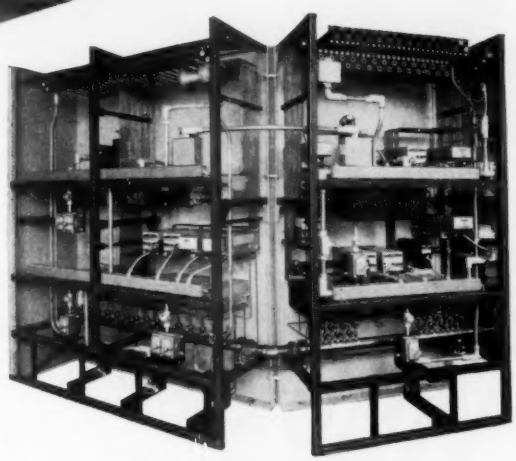
These plants produce electricity at a heat rate that is the envy of all other power producers. Our modern industrials get well below 5000 Btu per kwhr and many approach 4000. In turn, many of our large process industries consider steam at 100 to 300 psi as process steam. To generate any substantial amount of low-heat-rate power the boiler pressure must be over 1000 psi. With process-steam demands ranging up to 1,000,000 lb per hr the high-pressure boiler plant has real merit.

Typical conditions for a plant can be assumed as 400,000 lb per hr of process steam at 200 psig. When 1200-psi boilers were first offered years ago, the feed problem allowed using only distilled water in the boilers. So Fig. 7 was developed using process-steam evaporators in which 400-psi turbine exhaust generated 200-psi process steam. The latter was sent to the fac-

Creative Contributions
to Centralized
Process Control...

GRAPHIC PANELS

by FOXBORO



Typical back-of-panel view. Note open framework construction (easily enclosed if desired), terminals tagged for quick identification in field, neat arrangement of tubing and wiring, full accessibility to all instruments.

Years of experience in panel design and construction have equipped Foxboro Panel Engineers with many exclusive techniques . . . methods which bring you unequalled performance in centralized process control.

One typical feature is the use of aluminum strips and shapes, three-dimensional in effect, in bright, permanent colors, to symbolize flow lines and vessels. These are securely attached over the background finish, yet may readily be rearranged when necessary without marring the finish or leaving ugly holes. (If you prefer, painted graphic panels can be furnished.)

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Manufacturers of A COMPLETE LINE OF BOILERS FOR EVERY HEATING AND POWER REQUIREMENT

SUPERPRESSURE

Continued from page 208

tory and the former returned as condensate to the boiler. We developed 10,000-kw net power.

Some years later, when chemical feed treatment was perfected, we could do as in Fig. 8 and take turbine exhaust directly to process. Makeup was close to 100% but lowering exhaust pressure to 200 psi with 1400 psi at throttle doubled power output to 20,000 kw with the same process-steam flow.

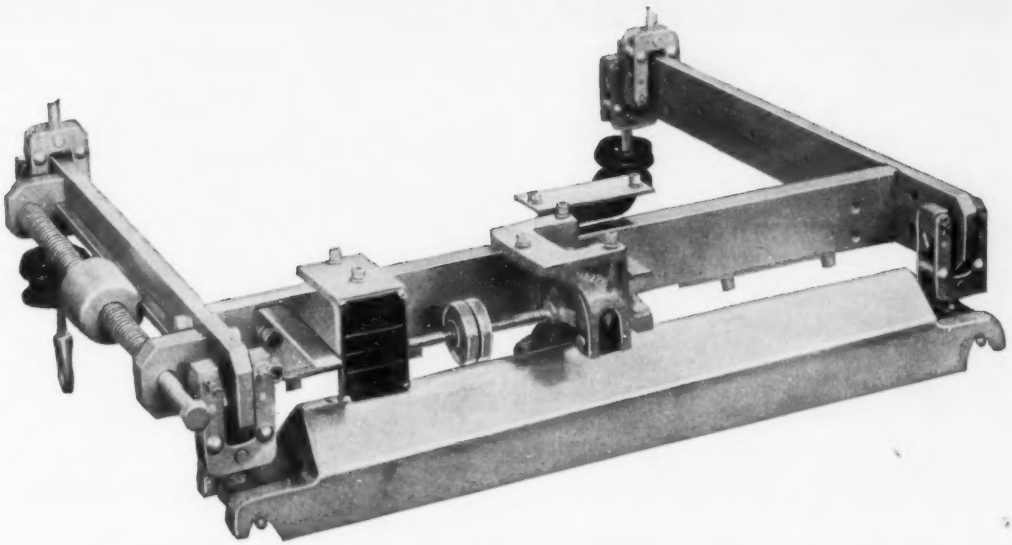
To develop more electric power, Fig. 9 was proposed. This used a mercury-vapor turbine exhausting into a condenser-boiler, which supplied both a steam turbine and process steam. This again doubled the power output to 40,000 kw with 400,000-lb-per-hr process-steam flow. Economies of this installation could not be demonstrated, but the demand for more power with the same process steam is still there.

Couldn't supercritical pressure be the answer? Fig. 10 shows what could be expected. Byproduct power could run to 40,000 kw. The problems, however, are very severe. Control of feed quality, with high makeup, needs much investigation to find a favorable answer.

Reliability and economics. Perhaps I have not stressed sufficiently the ever recurrent problems of adequate reliability and economics. The supercritical plant must make its way in the face of the stiffest competition. Present standards of reliability and availability must be matched or we vitiate all the economic advantages offered by high pressures. The proposals must promise many years of continued turbine performance without opening the case. Other components like heaters, pumps and "boiler" will have to do equally well. Present equipment reliability is remarkable. We can't afford to jeopardize reliability, or we will be saddled with a spare capacity burden that will be unbearable.

The first units offered will not meet these rigorous standards. That is simply the price we must pay for progress and development. But there must be ultimate attainment of the reliability goals. Then the inducements of increasing fuel economy in the face of rising fuel prices will become realities that can support the investment.

These are just a few of the problems that seem to stand out in this supercritical field. There are many others. Others that are presently recognized. But I am sure there are still more that will become apparent only with more study and actual use. I have every confidence, however, that given the manpower and the talent the solutions will be found.



Attention to Detail is the Reason Why

whatever you buy from Stock Equipment Company is of the highest quality. Take the weigh lever system illustrated above, for example. Top performance is assured because careful attention to design detail utilizes a non-welded steel assembly with steel loops. Hardened steel pivots and bearings in this light-weight unit mean low inertia and faster action with resultant greater accuracy.

No matter if it's the design of a pivot in a weigh lever system, the layout of the overall job of delivering and weighing coal between bunker and pulverizer, or the fit of a dust-tight slip joint connection (as illustrated to the left), Stock Equipment Company takes time to make sure that it is right. This attention to detail means a completely satisfactory and overall economical job for its customers.

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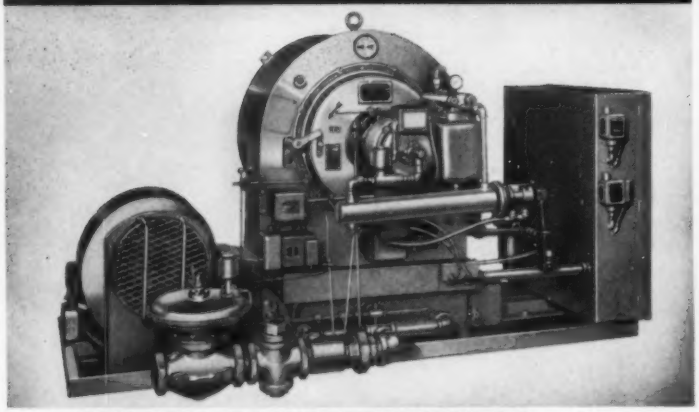

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- **Easy Installation**—Ray's packaged unit contains all combustion components completely wired, piped, and mounted on a structural steel base, ready to be installed on the boiler.
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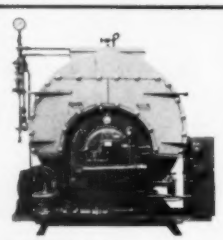
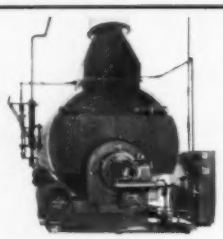
Write for complete details in catalog unit "Y"

Typical Boiler-Burner Units



TITUSVILLE—Ray



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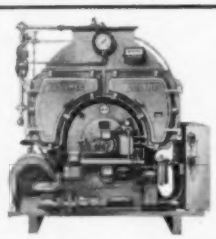

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ELEVATORS

Continued from page 98

Fig. 6, performs eight separate functions. Automatic smooth-start valve *A* permits the oil to bypass when the pump starts. This valve gradually closes, diverting oil to the jack so the elevator can start smoothly. High-pressure relief valve *H* guards against overloading the elevator mechanism from excessive pressures. This valve operates on a close pressure margin between the fully closed and opened positions. If the elevator is overloaded to the point where the car can't move, this valve opens, bypassing the full discharge into the tank.

Stopping valve. On units with heavy sheaves and large motors, an automatic stopping valve, also at *H*, unloads the system after car reaches the landing on up-cycle. It compensates for flywheel action of sheaves and prevents excessive slide or up-drift of the car.

A tank shutoff valve *T* isolates oil tank from remainder of equipment for quick repairs and servicing of the power unit. A check or oil-lock valve *O* closes when car comes to rest and locks it in that position on the oil column. This valve closes quickly without any perceptible reverse-flow of oil and without shock.

Landing stops. An automatic leveling valve *L* insures accurate landing stops within 0.25 in. under a wide load range. It gradually closes when the car is slightly above the landing, permitting the car to level back automatically at slow speed.

Main lowering valve *M*, hydraulically controlled through an electric pilot valve, opens gradually giving a smooth down-start. The valve also closes gradually, bringing the car to a smooth stop. Manual-lowering handle *F* permits lowering the elevator if power fails or adjustments have to be made.

Equipments described in this article give a general idea of the valve functions as applied to electric-hydraulic control. An exception is the power unit made by the Shepard Elevator Co that incorporates diaphragm-operated accelerating and lowering valves. These are pilot operated from jack pressure; a static pressure always exists because of weight of car and load.

General Elevator Co uses up to three separate motor-driven pumps for smooth control of their electric-hydraulic elevators. These pumps are controlled in sequence, starting and stopping the elevator smoothly in addition to making accurate landings.

Manufacturers who supplied data for this article are the S Heller Elevator Co, Murphy Elevator Co, F Rosenberg Elevator Co, White-Evans Elevator Co, besides those mentioned in the text.

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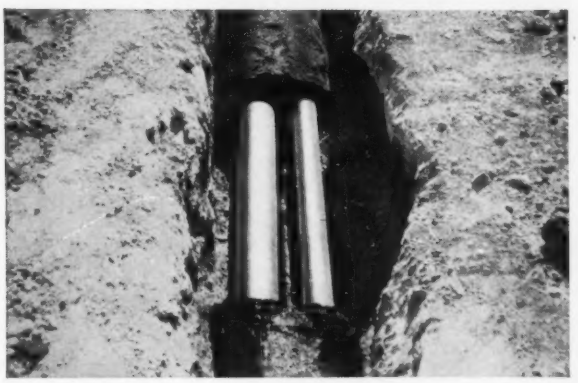

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ZONE 1 Dense, semi-plastic coating bonded tightly to pipe surface. This Zone is waterproof and a thermal and electrical insulator.
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3. GILSULATE—Delivers Permanent Triple-Zone Protection—Three tough, massive circular sheaths completely and permanently protect the pipe, cut heat loss down to 8% to 11% of bare buried pipe. Triple-zone protects against all buried line corrosion conditions: water, roots, acid, alkalis, bacteria, etc.

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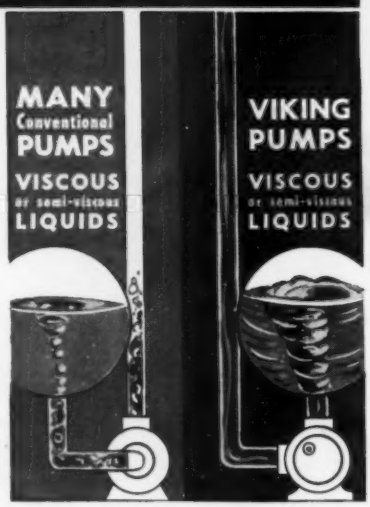

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MARMADUKE

Continued from page 146

ior, I carried a marine engineer's union card away back before you were born. And I know you can strike oil without blasting with dynamite'. Not knowing what I was driving at he shoved off. I got back to work.

"The works manager would have given all of us the heave-ho if I was ungrateful enough to ask for a new gang of welders after he agreed to let my boys stay on. 'You can ballast a ship so she capsizes or you can ballast her so she keeps on an even keel', I always said. And I expected to stay afloat.

"We kept right on building. A few days later the delegate showed up again. When he saw my pipe welders still on that job, he not only worked up a head of steam but blew a gasket for good measure.

" 'Didn't I order you to take those pipe welders off this job and hire structural welders', he roared, popping his safeties.

" 'Why in hell do I need structural welders to build a pressure vessel?' I asked calmly.

" 'A pressure vessel', he exploded, this time stripping a gear. 'Where's the pressure vessel?'

" 'I can see you're not an engineer,' I informed him. 'That's a pressure vessel that we've been building all this time.'

"The delegate blinked his eyes and dropped the cigaret from his hatch. 'You trying to be funny by telling me that Quonset hut over there is a pressure vessel?' he asked, slowly giving me the once over as if I were three sheets in the wind.

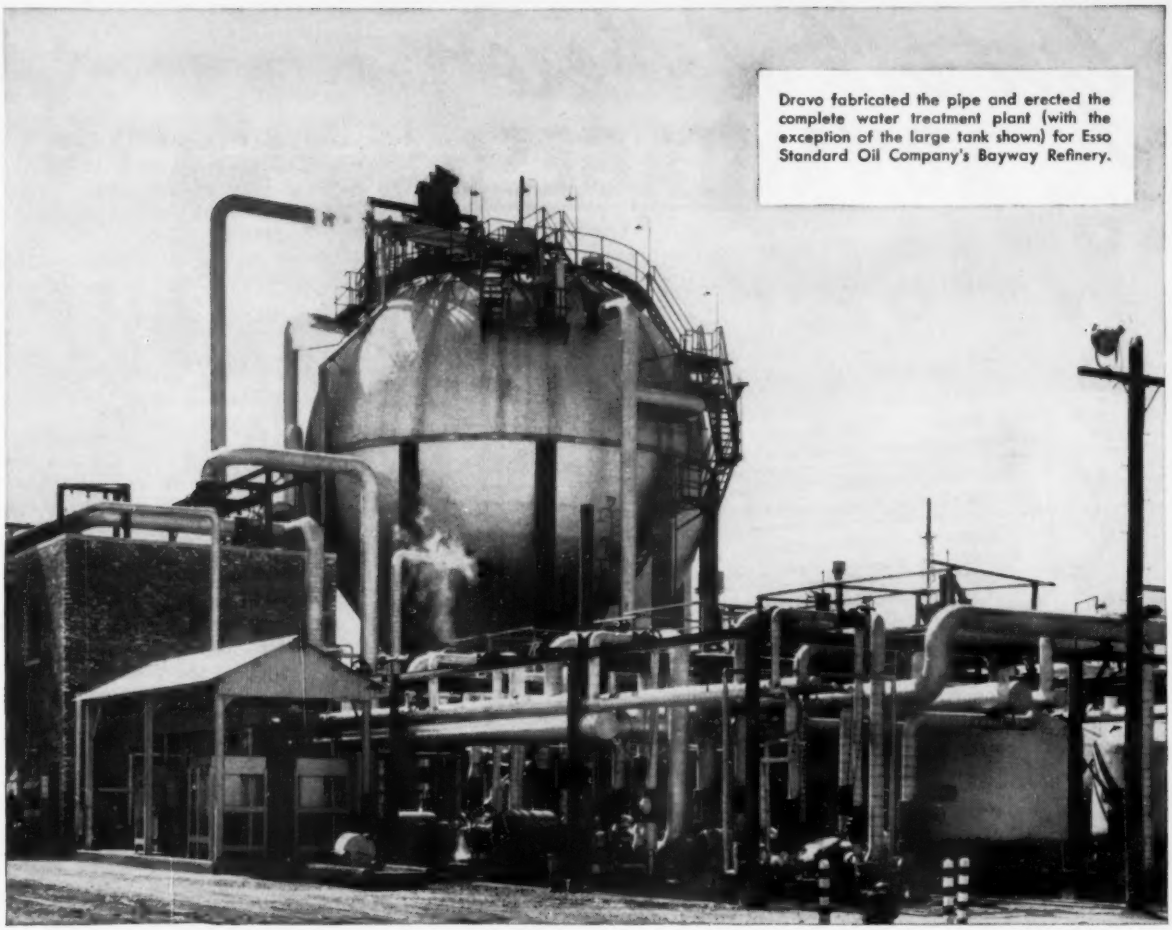
" 'That's right, *junior*', I answered. 'Any north-end of a southbound Texas horse can see that's a pressure vessel for compressed air.'

" 'Compressed air?' he barked, 'I guess that's gonna be a blimp or something and not a Quonset hut at all, is that it?'

" 'Take a look at those horizontal pipes near the floor,' I said quietly, 'they all have half-inch nipples welded in every 12 feet. They're air hose connections. And the pipes are welded together so compressed air fills every part of that framework. I've got it figured out as having the same capacity as a 5-ft-diameter air-receiving tank that would stand about eight feet high.

" 'When we hook our air compressor to that pressure vessel', I explained, 'she'll carry 110 psi. And it takes good pipe welders to make those welds pressure tight.'

"The delegate just stood there, about to flip his lid. I kept explaining, 'When that receiving tank is finished, we'll move the air compressor inside and hook



Dravo fabricated the pipe and erected the complete water treatment plant (with the exception of the large tank shown) for Esso Standard Oil Company's Bayway Refinery.

At ESSO . . . outdoor water treatment plant pays off

This new water treatment plant for Esso Standard Oil Company's Bayway Refinery, Linden, N.J., shows how out-of-the-ordinary outdoor construction can pay off. Although it isn't the custom to place a water treatment plant outdoors in northern climates, space limitations made it necessary . . . and with Dravo furnishing the construction "know-how," Esso now has in operation an effective 200,000 gal per hour water treatment plant on a site only 84 ft by 130 ft.

One of the problems involved in this construction was unstable surface conditions. This was solved by sinking all outdoor tank and pump foundations 7 ft below surface. Switchgear was mounted on a concrete slab under a protective roof.

Other equipment called for in the new plant includes a sedimentation tank, 12 anthracite filters, 2 lime mixing tanks with agitators, one phosphate mixing tank, 6 zeolite softeners, and pumps with capacities from 1500 to 3500 gpm. A brick structure provides room for chemical storage and houses chemical mixing tanks and main control panel. All piping, six inches or larger was fabricated on automatic welding equipment at Dravo's Marietta, Ohio Pipe Fabrication Plant.

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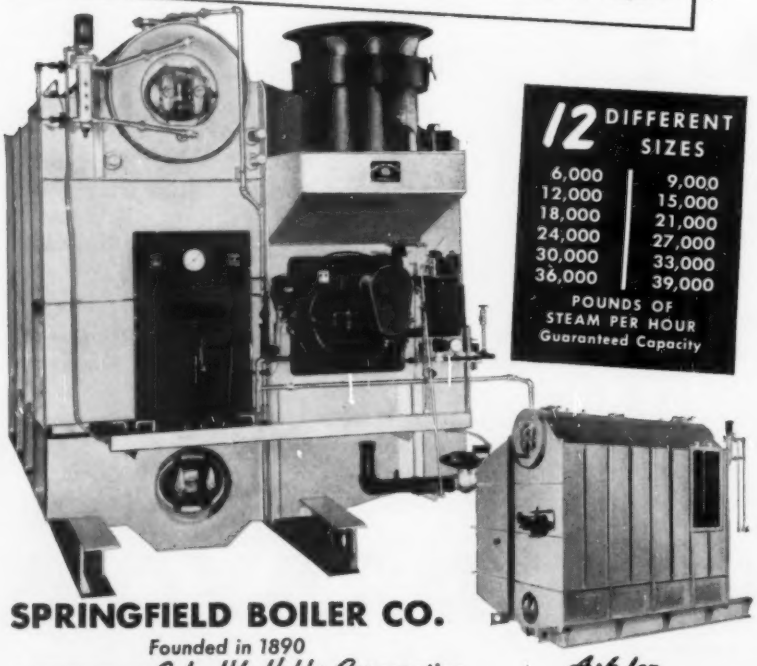
✓	**6.** EASY TO CLEAN—Quick, easy acid cleaning by qualified personnel is permissible. Clean internal design; no difficult pockets or corners, no hand holes—all tubes connect directly to drums.
✓	**7.** EFFICIENCY—Over 81% with oil. Automatic, semi-automatic, or manual control. Gas, oil, or combination firing. Underwriters' approved.
✓	**8.** COMPLETE UNITS—Ready to connect to fuel, water, electrical, and steam lines—with no extras required for setting and other materials. Design pressures of 200, 300, 600, and 900 psig. Send for complete information.



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MARMADUKE

Continued from page 214

into her. With drain valves at all four corners of the floor, we'll keep her free of condensate. And we'll hook a relief valve near the top at the other end.'

"I guess that was too much for *junior* because he weighed anchor and shoved off. Sounded like he was muttering 'a compressed air quonset tank, now I've seen everything'. And he had."

S.M.E.

STEAM AND/OR DIESEL

Continued from page 87

Payroll costs depend on the number of men employed, prevailing wage rates, and the average work week. We've assumed a 42-hr average work week utilizing four sets of shift operators. Fig. 4 shows station personnel, including normal maintenance crew, expressed in men per 1000 kw for steam and diesel plants, up to 20,000 kw. The curves are based on 8760 hr of operation per year. Notice that the diesel plant shows an appreciable advantage in the smaller sizes with the difference getting smaller as station capacity increases, and disappearing at 20,000 kw.

Cost per man-year varies widely with wage scales. Chances are that the steam plant will require men of slightly higher average skill, resulting in higher wage levels for steam units in any given locality.

Maintenance and other costs, as might be expected, are a highly controversial topic. Advocates of both steam and diesel claim that maintenance costs are less with their equipment than with the other type.

Experience with both steam and diesel shows little, if any, difference in maintenance costs under the same normal operating conditions. Any slight differences that may show up seldom affect the decision as to type of equipment selected. Since we've included maintenance personnel in station manpower requirements, we refer here only to maintenance materials and work that require use of outside help. These costs usually range from 0.01¢ to 0.05¢ per kwhr except for very small plants.

Cost of supplies and other expenses also indicates little to recommend one type of unit over the other. Fuel costs shown in Fig. 2 include lube oil for diesel equipment. With this item removed from supplies and other expenses the remaining costs for diesel are in line with those of steam plants under normal operating conditions. These miscellaneous expenses, again except for very small plants, usually vary from 0.01¢ to 0.03¢ per kwhr.

Other factors. There are times when

NO Reducing Valve Needed

Here's real economy in temperature control.

Because Spence Temperature Regulators are designed to limit heater steam pressures to an adjustable maximum, the need for a separate reducing valve is completely eliminated.

The Spence Regulator takes steam directly from the boiler or high pressure line, reduces the pressure and regulates the flow as required to maintain a constant temperature output from the heater.

This means one relatively small combination pressure and temperature regulator replaces a reducing valve of the same size and a larger temperature regulator. Practically the entire cost of the large separate temperature regulator is saved. And, the total saving would also include the cost of a 3-valve by-pass along with all labor for installation.

This design feature is just one of the reasons for the thousands of Spence installations throughout American industry. *For details of other important design features, write for Bulletin T50.*

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TYPE ET150
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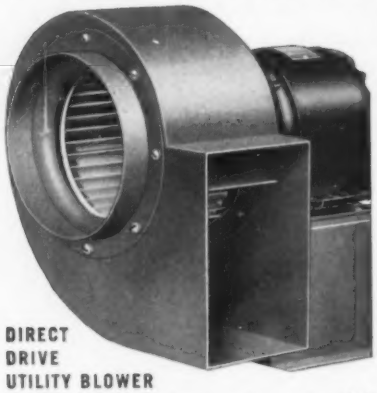

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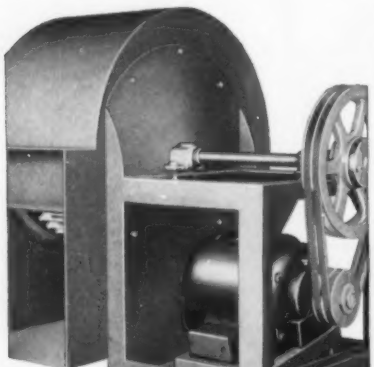

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STEAM AND / OR DIESEL

Continued from page 216

comparison on a dollar basis doesn't tell the whole story, especially when costs of the two are a standoff. Here are other factors you may want to consider: (1) construction time—usually shorter with diesel equipment (2) cooling water—diesels require less (3) fewer units—steam plants usually have fewer and larger machines (4) reliability—about equal (5) simplicity—favors diesel (6) space—diesels require less (7) starting time—diesels require much less (8) fuel flexibility—steam units use greater variety.

The next article will discuss specific examples of comparison between steam and diesel applications.

CONTROL BATTERY

Continued from page 83

pacity is found to be 240 amp, or 60 amp per positive plate. And from the one-minute curve on Fig. 2, note a minimum temperature of 55 F reduces the amperes per plate to 82%. Thus the available current per positive plate is 60 × 0.82, or 49.2 amp. Divide this figure into the 90 amp required to close one switch, and you get 1.83 positive plates-per-cell to handle the switchgear load.

Shifting to the pilot light requirement, 8-hr service, consult the curve, Fig. 1, to ascertain capacity of 5 amp (40 amp-hr in 8 hr) for the type battery being considered at the 8-hr rate. The 8-hr curve on Fig. 2 shows 87.4% capacity at 55 F. Therefore, the available current per positive plate at the 8-hr rate is 5 × 0.874, or 4.37 amp. Divide this figure into the 1-amp requirement for pilot lights, and you get 0.23 positive plates-per-cell.

Finally, for the emergency-lighting-load 3-hr service, again consult Fig. 1. At the 3-hr rate you find an availability of 10 amp per positive plate (30 amp-hr in 3 hr). The 3-hr curve on temperature correction chart, Fig. 2, shows 86.6% capacity at 55 F. Thus the available current per positive plate, at the 3-hr rate, is 10 × 0.866, or 8.66 amp. Dividing this figure into the 7-amp requirement for emergency lighting yields 0.81 positive plates-per-cell.

The total positive plates-per-cell for all three loads is, therefore, 1.83 plus 0.23 plus 0.81, or 2.87 positive plates-per-cell. The fraction 0.87 exceeds 5% of the total figure. Thus 3 positive plates-per-cell is correct.

This means that a 7-plate battery is quite sufficient, even for service at 55 F, and there is no need to specify the 9-plate size from which calculation began.

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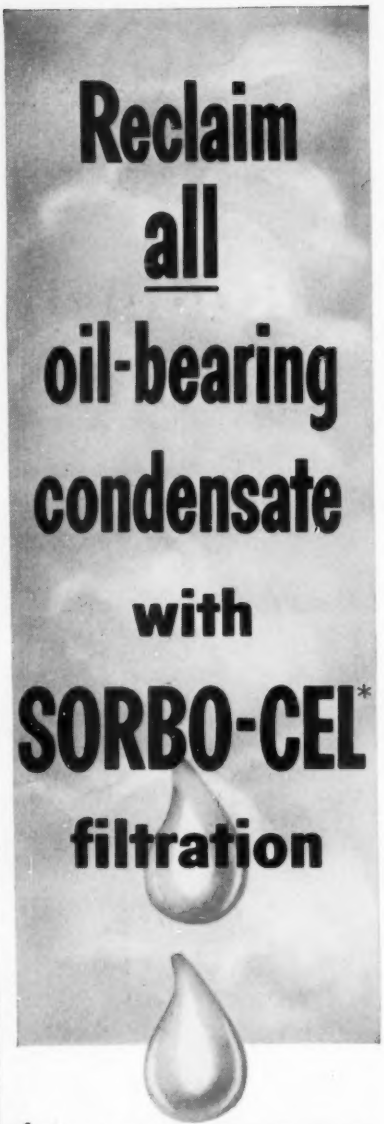

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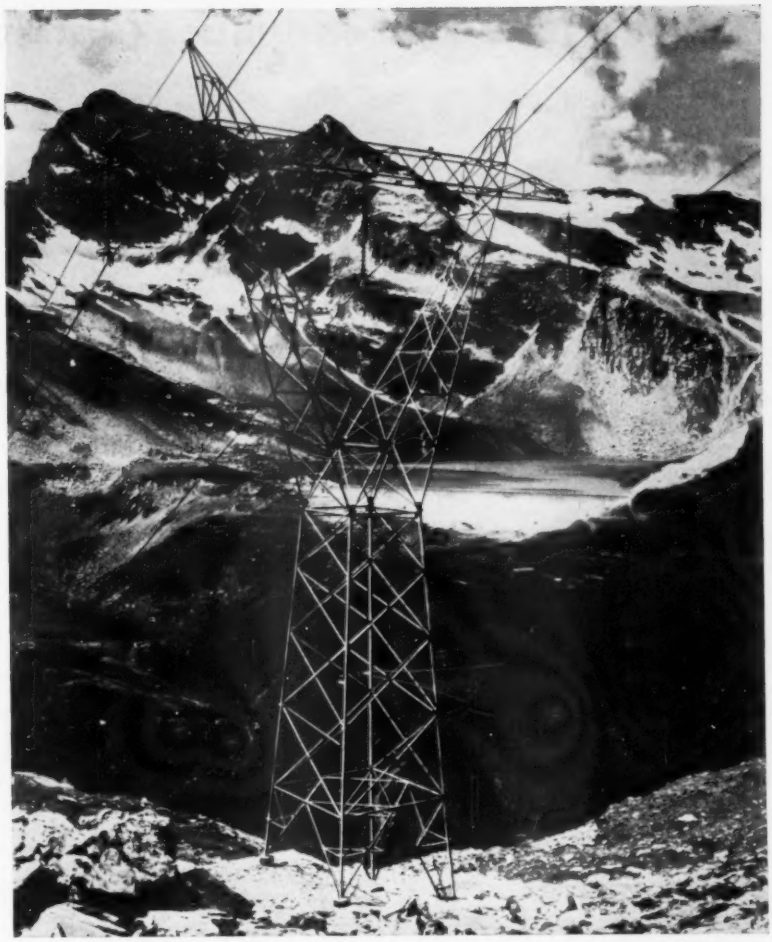

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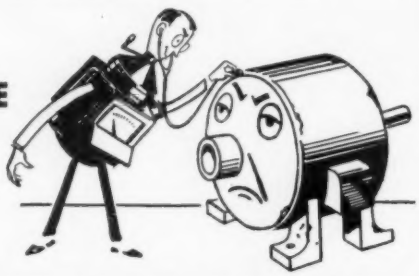

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ATOMS

Continued from page 92

Moderator is a material used in the core of some reactors to moderate or reduce neutron speeds to a level that raises the probability of fission occurring when the neutron strikes a U-235 nucleus.

Shielding keeps the deadly radiations, such as alpha and beta particles and gamma rays given off by fissioning, within the reactor. The entire reactor must be surrounded by many feet of massive and heavy shielding to protect operators.

Reflector also completely surrounds reactor, within the shielding, to bounce escaping neutrons back into the core. This saves on the amount of nuclear fuel needed by making more efficient use of released neutrons.

Control of the reactor is exerted by inserting neutron-absorbing materials to keep the chain reaction at a desired level. They might be in the form of rods that are moved in and out of the pile to soak up some of the neutrons and keep the "blizzard" of neutrons from growing too big.

Cooling system of the reactor carries off the heat from the core to generate steam in another apparatus. Heat must be removed continuously to keep core temperatures from rising too high and melting down the reactor. Possible coolants include: air, hydrogen, helium, water, fused salts, and liquid metals, such as lead-bismuth alloys, sodium. sodium-potassium alloys.

PORCELAIN ENAMEL

Continued from page 113

cylindrical furnace, cone permits even distribution of flue gas. That increases gas velocity at top of furnace as combustion temperature is decreased. Coated sheet-steel slashed costs over previously used heavy stainless cast plates, photo, p. 111.

These examples show how porcelain enamel is forging ahead. While each new application requires study, constant improvement in both coatings and firing techniques is easing this problem. There's a world of difference in coating a flat, thin sheet of steel and a heavy-duty cast-iron piece that may vary in thickness.

As to whether an item can be coated, only a well-versed engineer or porcelain-enamel firm can say. Entire field of porcelain coating is constantly changing as research uncovers new ideas and methods. All this activity points to more and more uses and savings for you.

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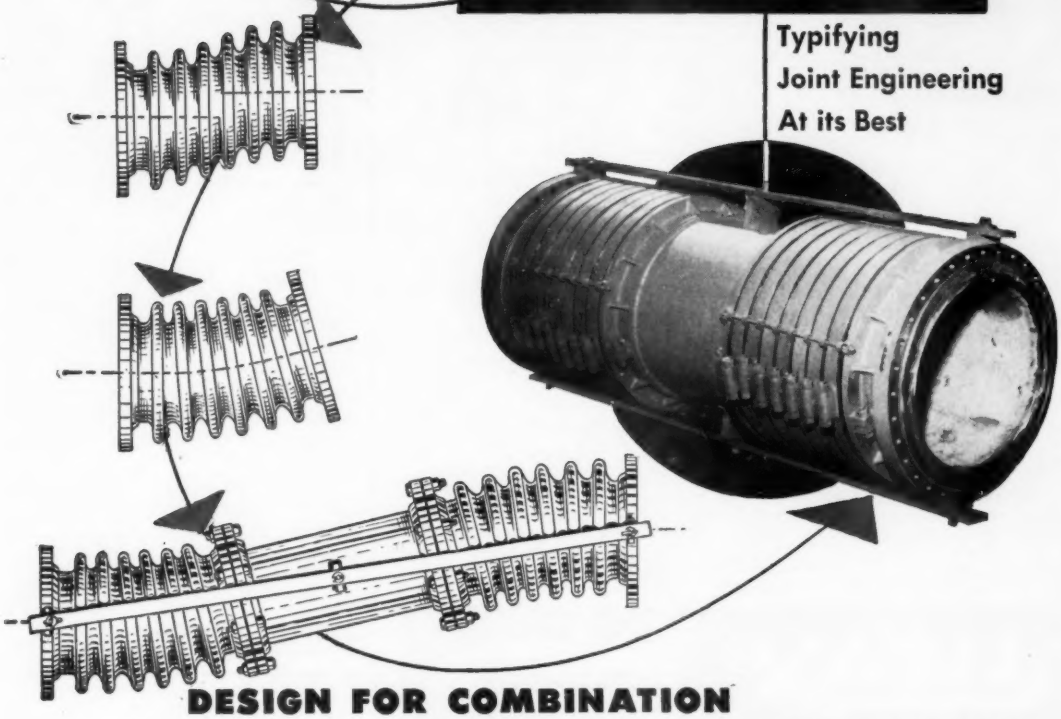

DESIGN FOR COMBINATION LINEAR-SHEAR-LATERAL MOVEMENTS

Study these sketches showing (somewhat exaggerated, of course) several of the more complex movements to which expansion joints are often subjected. Do you have such pipe line conditions? Do you have any installation coming up that might involve such movements?

Here's the Badger Joint that is designed for just such a problem: the TANDEM JOINT. It's available in both Self-Equalizing and Non-Equalizing design. The joint movement is controlled by the tandem bars pivoting on a pin in the connecting nipple. Permissible shear or lateral movement depends upon the overall length as well as the number of corrugations in each unit. Each tandem unit is designed to suit the individual job requirements.

The Tandem Joint is but one of several special types designed for complex pipe line movements. We'll be glad to study your problem and make recommendations. Should yours be a straight linear traverse—as most installations are—we have a wide range in Directed Flexing, Self-Equalizing and Non-Equalizing Joints made of copper or stainless steel, with flanged or welding ends.

Badger Expansion Joints come in a variety of types and a wide range of sizes: Directed Flexing, Self-Equalizing for longer traverses and higher pressure; Non-Equalizing, for shorter traverse or when pressures are low. Tandem Joints for combination axial and lateral movements; Clevis Joints for angular rotation.

Special Vibration Control Joints; Flexible Pipe Line Seals for watertight connection between pipe and flood walls.

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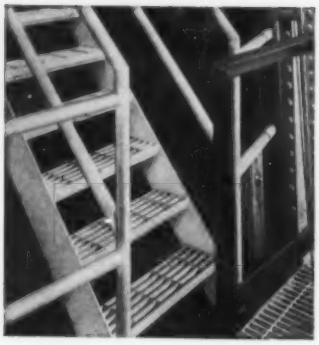

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Here's a sure way to keep accident claims down and at the same time, give employee morale a boost. Install Hendrick Shur-Site Treads for stairs and fire escapes. Hendrick treads not only improve safety records but their 90% open area lets more light and air in—improves working conditions.

Bars are square edged and uniformly spaced for extra wear and long life. A heavy flanged nosing-bar provides extra reinforcement and plainly marks the edge of each step for safety's sake. Furnished in standard sizes or in special widths and lengths they're shipped ready to bolt direct to stair stringers. For more information write Hendrick direct.

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HEAVY FUEL

Continued from page 121

If we had continued operation under slagging conditions, wire-drawing between the patches of slag would have destroyed both valve and seat in short time.

Operating on the assumption that there is a rate of deposit and a rate of wearing off for this slag, we've come up with some interesting observations. Deposit rate depends on the nature and quantity of ash dissolved in the fuel, and on the rate of fuel flow. Wear-off rate depends on the hammering action of the valves.

Our operations show that one supplier's bunker C, when used at full load, produced slag. This same fuel, when burned at a 70% average load, showed no slagging. Furthermore, under the latter conditions, another supplier's bunker C resulted in a serious slag condition. Also, a 79-hp diesel, running at 800 to 1000 rpm at nearly full load, produced no slag troubles when burning the same bunker C that ruined the valves of a 1645-hp diesel running at 327 rpm.

We're hoping that rotation of the exhaust valves will increase wear-off rate enough to permit using any bunker-C fuel.

BOILER ERECTION

Continued from page 103

per 100,000 lb of water in the boiler. The manufacturer will often furnish boiler-water capacity. If necessary, calculate it from physical dimensions of the various water-containing parts as shown on boiler prints or specifications, or as actually measured.

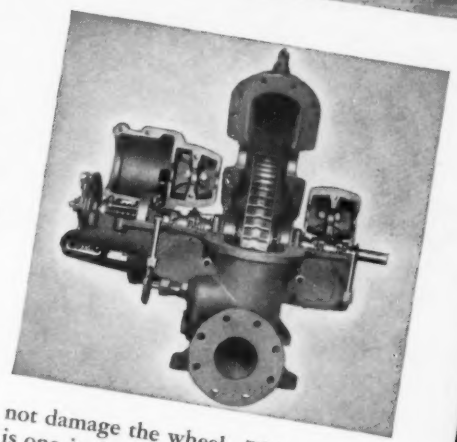
Here are four combinations of chemicals that have given satisfactory boilouts, listed in ppm:

Combination	*A*	*B*	*C*	*D*
Soda ash	2000	——	3000	——
Caustic soda	2000	1000	3000	150
Trisodium phosphate	250	2000	——	2600
Sodium metasilicate	——	——	——	800

New electronic brain, the *Early Bird,* is specifically designed for computing the cost of delivered electric power in the complex Southern Company System. With this computer, designed and manufactured by Leeds & Northrup Co, the power supply coordinator at Birmingham will supervise station loading in the Southern Co system. Fuel costs at each station are set on the computer, which takes into account transmission losses and generating costs in arriving at the ultimate cost of delivered power.

TERRY

LARGE CLEARANCES take the "worry" out of Turbine Operation

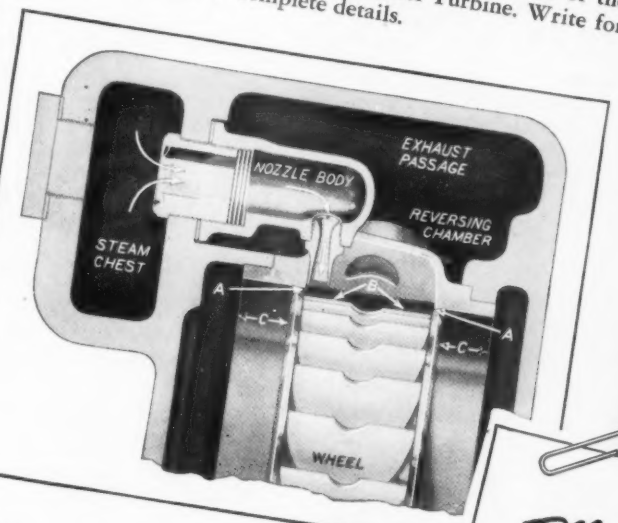


In a Terry Solid-wheel Turbine the power-producing action of the steam in the wheel takes place on the curved surfaces at the back of the buckets. This unique design permits unusually large blade clearance—see B in the diagram.

Even if this clearance becomes reduced, there is no real cause for worry. The blades still cannot foul because they are further protected by projecting rims at the sides of the wheel. These rims, which also have ample clearances (AA), will take without damage any rubbing that may occur.

Side clearance, CC, is so large that end-play from external thrust will not damage the wheel. This clearance is one inch or even greater.

Large side and blade clearances are only two of the many features of the Terry Solid-wheel Turbine. Write for complete details.

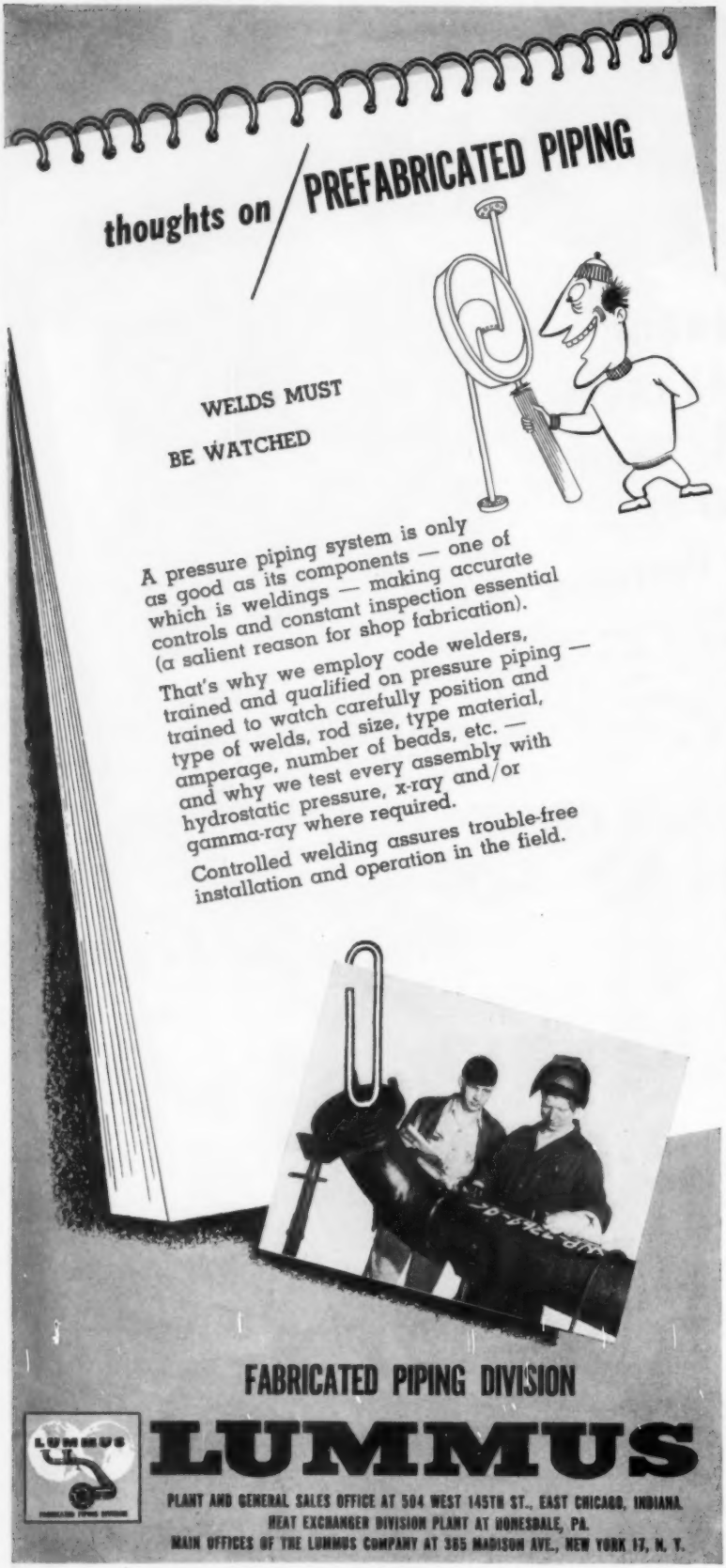


THE TERRY STEAM TURBINE CO.
TERRY SQUARE, HARTFORD 1, CONN.

TT-1191

Memo

Send for a copy of bulletin S-116 which describes the many advantages of the Terry Solid-wheel Turbine.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A pressure piping system is only as good as its components — one of which is weldings — making accurate controls and constant inspection essential (a salient reason for shop fabrication).
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More TECHNICAL BRIEFS

Begins on page 154

of most operators for working outdoors.

Factors against outdoor construction include greater maintenance difficulty in dusty locations and during cold weather, maintenance delays can make scheduled outages uncertain, corrosion is greater and more frequent painting is needed, there may be noise problems if station is near a residential area, extra costs to protect lines against freezing, and small enclosures exposed to direct radiation from the sun may be difficult to ventilate.

While it is not possible to give detailed examples of the added cost increments for all the outdoor equipment discussed in this paper, the added cost of turbine-generator and electrical equipment for a 100,000-kw outdoor station would be about $1.65 per kw. This is small compared to the $3 to $8 per kw saving possible. So the economics of a particular situation will probably be determined by other plant components, and by relative maintenance and operating costs. *AIEE paper No. 54-301.*

Economic factors affecting selection and replacement of power plant equipment. *By Gerald J Matchett, director, National Center of Education and Research in Dynamic Equipment Policy, Illinois Institute of Technology.*

Modern industrial operations are characterized by the fact that there are many different methods and a variety of equipment available for accomplishing any given production aim. Management decisions on selection and replacement of capital equipment can be made on a scientific basis only when a careful analysis is made of the possible equipment alternatives. It is well known that in the power industry, as in almost all others, the most efficient plant and equipment alternative from the technological point of view may not be economically the most efficient one.

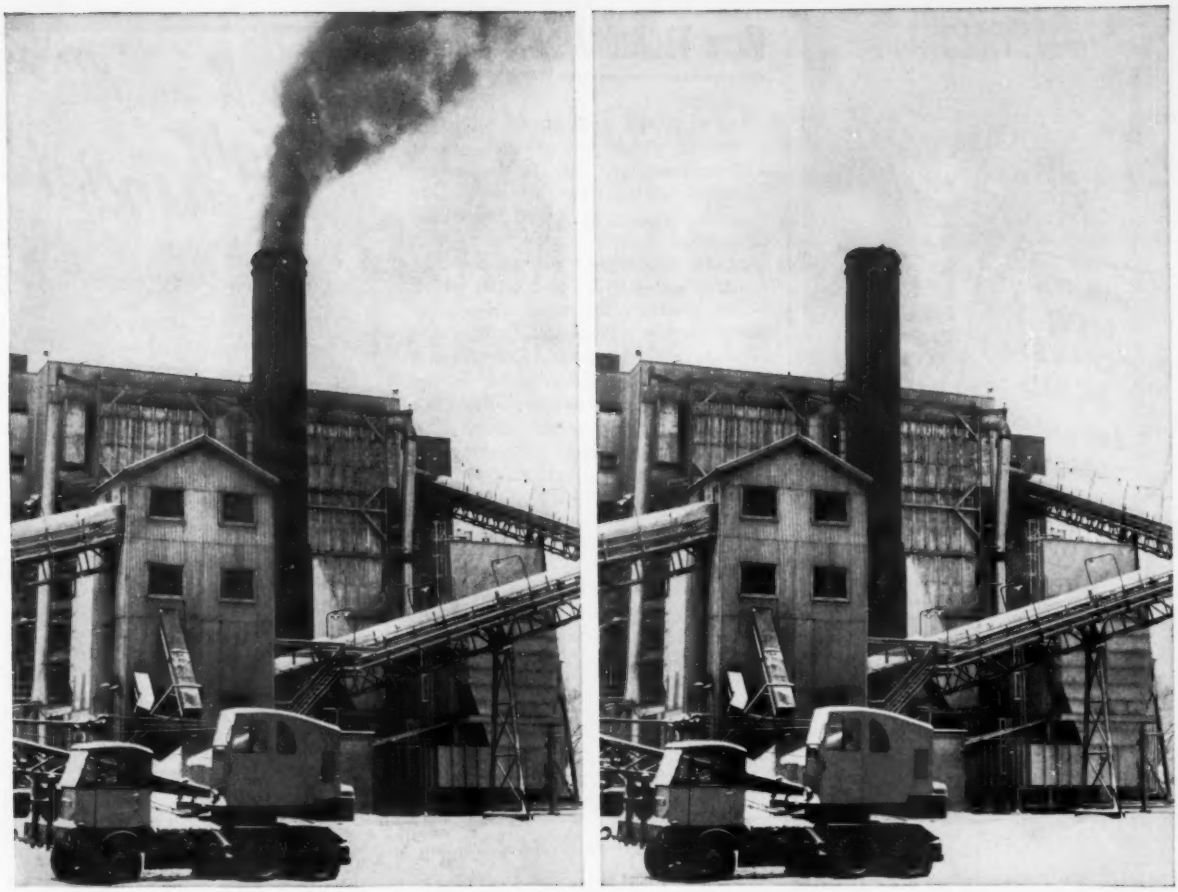
Factors requiring consideration include economic efficiency, cost relevancy, treatment of investment charges, capital recovery, other costs, treatment of operating costs, and the significance of various costs.

The paper discusses all these factors. Illustrative examples help point up their importance in typical power-plant installations. *APC paper.*

The Gallatin Steam Plant of the Tennessee Valley Authority. *By C E Blee, Chief Engr, and H J Petersen, Head Mechanical Engr, Tennessee Valley Authority.*

The power system of TVA is under-

Directions for ordering papers on p 230



Fly Ash Problem Solved By Central Station

This Pennsylvania utility felt that as long as you can *see* dirty stack discharge, you have a problem. To solve it, they decided to insist on fly ash collection equipment with very high efficiency.

The electrical precipitators they chose, which were placed after existing mechanical collectors, are Cottrells, designed and built by Research Corporation. Their effectiveness is demonstrated in the above unretouched photographs. At the left, the precipitators were turned off long enough to take the picture showing the volume of fly ash discharged by the boilers. At the right, the precipitators are turned back on. Stack discharge is visually clean.

This is another example of industry's trend toward establishing its own higher standards for nuisance abatement. Research Corporation, which has made more fly ash installations than any other company, cites the following comparison:

In the period from 1923 to 1939 only 11% of its power plant customers specified fly ash collection efficiency of 95 to 98%. In recent years, that 11% has risen to fully 90%.

One reason, of course, is the generally increasing emphasis on community relations. Another factor is that farsighted companies are anticipating stricter smoke regulations. They are anxious to install equipment that will end their smoke problems now and also prevent such problems from occurring in the future.

Still another factor is this. In recent years, with modern coal pulverization and advanced boiler design, there has been an increase in the fineness of fly ash particles. This calls for the most efficient equipment available.

Read—in Bulletins FA and MI—about Cottrell equipment and the Research Corporation's MI Rapper. This device eliminates rapping puffs and enables the precipitator to maintain, continuously, its high collection efficiency. Write for your copies today.

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More TECHNICAL BRIEFS

Begins on page 154

going a change from almost all hydro to one in which steam-electric power will predominate. This is the history of almost all the large, growing utility systems initially supplied primarily from hydro.

In each case there is presumably some combination of hydro and steam which would produce the most economical power supply. What this relation is depends on the conditions of hydro and steam-power supplies available in the system and its load characteristics. The question is really academic since, to be realistic, it comes down to meeting the load demands in a practicable manner.

In the case of TVA the impact of unprecedented loads, spearheaded by AEC requirements and other defense agencies, left no choice but to go ahead with a program of steam-plant construction which has developed into an undertaking of sizable proportions.

Remarkable advancement has taken place during the period of steam-plant construction on TVA. So we find progressively changing characteristics of the units installed on the TVA system. No two stations are duplicates—a fact which has not lessened the heavy design load.

Some of the features of this plant include one boiler per turbine, no cross connections between units, concentration of operating functions on two levels—the basement and grade, partial outdoor construction, three air preheaters per boiler, end-to-end layout of turbines, and use of reheat. *APC paper.*

Fuels

Petroleum's place in the fuel market. *By Charles J Hedlund, Standard Oil Co of N. J.*

Oil has played an important role in the energy markets of the world—a role that has changed in nature from time to time. Even in ancient times petroleum was used in minor ways. But its importance as a fuel really began when Colonel Drake drilled his first well in Pennsylvania 95 years ago.

Rock oil, as crude petroleum was known in those days, found its first important use as an illuminating fuel. Kerosene was the main product of this early oil industry. It was first used in lamps and later applied to cooking and heating. Use of heavy fuel oil for ships, railroads and industry also began to be of increased importance.

In 1952 coal supplied about one-third of the nation's energy. Petroleum fur-

Directions for ordering papers on p 230

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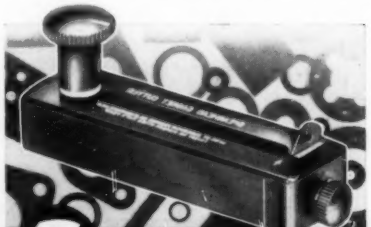

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CINCINNATI 12, OHIO
QUALITY-PRECISION-SERVICE SINCE 1920

Eastern Representative
MACKSONS CO., 125 Cedar St., N.Y. 6, N.Y.

3 years in a row Cooper-Bessemers help R.E.A. Plants win top awards

For the third straight year, the DIESEL PROGRESS Bronze Plaque, for the most efficient and economically operated Rural Electrification Administration plant, goes to a co-operative equipped with Cooper-Bessemer engines.

In 1953, as in 1952, Wolverine Electric Co-op's Johnson Plant at Hersey, Michigan, was the *first* choice. Here, three Cooper-Bessemers are part of the engine team that generated power throughout 1953 at an adjusted net operating cost of only 6.48 mills per kilowatt hour. The top award of 1951 was presented to the Graham County Electric Co-op, Pima, Arizona, powered by five super-charged Cooper-Bessemer Gas-Diesels.

Eight of the fifteen awards presented during the history of the competition have gone to R.E.A. plants powered exclusively by Cooper-Bessemer units. Power for *two* additional award winning plants has been shared by Cooper-Bessemers. *Ten out of fifteen* . . . an impressive record of dependable performance, lasting economy and minimum maintenance.

Such *consistent* operating efficiency, low maintenance, and lasting economy can go to work for you, too. For heavy-duty power needs . . . Gas-Diesel, Diesel or gas engines . . . remember Cooper-Bessemer. Consult with our nearest representative who will gladly work with you on your power problems.

New York City • Seattle, Wash. • Bradford, Pa. • Chicago, Ill. • Dallas Houston, Greggton, Pampa and Odessa, Texas • Washington, D. C. Shreveport, La. • San Francisco, Los Angeles, Calif. • St. Louis, Mo. Gloucester, Mass. • New Orleans, La. • Tulsa, Okla.

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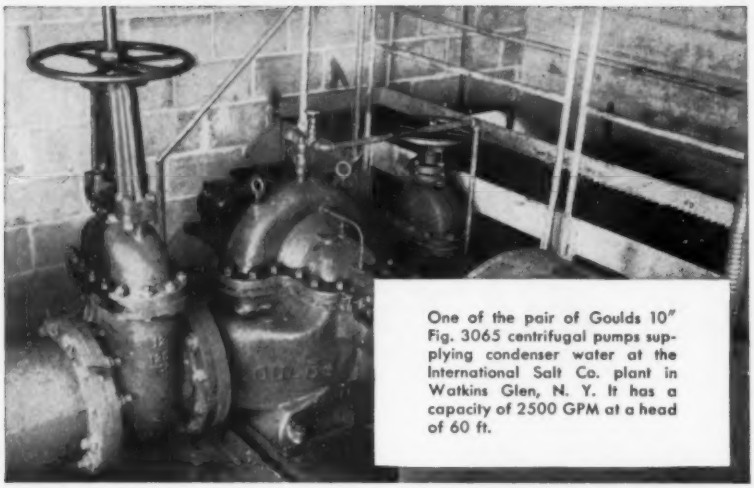
DIESELS • GAS ENGINES • GAS-DIESELS • ENGINE-DRIVEN AND MOTOR-DRIVEN COMPRESSORS



One of the pair of Goulds 10" Fig. 3065 centrifugal pumps supplying condenser water at the International Salt Co. plant in Watkins Glen, N. Y. It has a capacity of 2500 GPM at a head of 60 ft.

30-year record of old Goulds pump wins job for two new ones

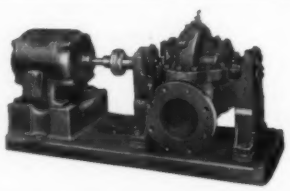
Barometric condensers at the plant of the International Salt Company in Watkins Glen, N. Y., were water cooled for more than 30 years by an old Goulds Fig. 3030 centrifugal pump, installed in 1919.

When the capacity of the plant was enlarged 5 years ago the old pump was replaced. Its excellent service record was an important factor in the selection of two new Goulds 10" Fig. 3065 pumps. Now these, too, have been in continuous operation for more than 5 years, with only normal maintenance care.

And the old one—well, that's still running, having been transferred to the less exacting task of pumping water through the degasifier.

The full Goulds line includes pumps for practically every industrial application. And Goulds engineers have a background of 106 years of pump manufacturing and liquid-handling "know-how." If you have any pumping problem, just drop us a line. Your inquiry will receive prompt attention.

Since International Salt installed its Goulds Fig. 3065 pumps, this Goulds Fig. 3405 has been developed as a still further improvement in pump design and economy. Bulletin 721.6 tells the story in detail.



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Goulds PUMPS INC. Seneca Falls New York

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More TECHNICAL BRIEFS

Begins on page 154

nished a little over 40%; natural gas somewhat more than 20%. The volume supplied by coal in 1952 was roughly equal to coal's volume in the immediate prewar years, when coal supplied over half the nation's energy. Petroleum and natural gas have furnished essentially all the growth in the overall energy market in the last 25 years. Oil consumption in 1952 was almost four times that in 1925; natural gas grew about seven-fold in the 25 years.

Supplies of oil products for generation of electric power appear adequate. The two products chiefly involved in electric power generation are heavy fuel and diesel fuel. Supplies of the latter are ample enough to meet any requirement of the foreseeable future. Spare capacity for crude producing and refining is of the order of 15%, and in transportation somewhat less, but still ample.

Most heavy fuel is sold in competition with coal, so their prices are never far apart. The competitive price of heavy fuel oil is usually less than that of domestic crude, and considerably less than that of other petroleum products.

As a result, the domestic refining industry has tended to minimize the yields of heavy fuel oil. It has dropped from 27% in 1945 to less than 19% in 1952. This declining percentage yield has not quite been offset by the increased volumes of crude oil processed, so the volumetric production of heavy fuel oil from U. S. refineries has tended to decline slightly. *APC paper.*

Future of coal in power generation. *By G A Lamb, Manager, Business Surveys, Pittsburgh Consolidation Coal Co.*

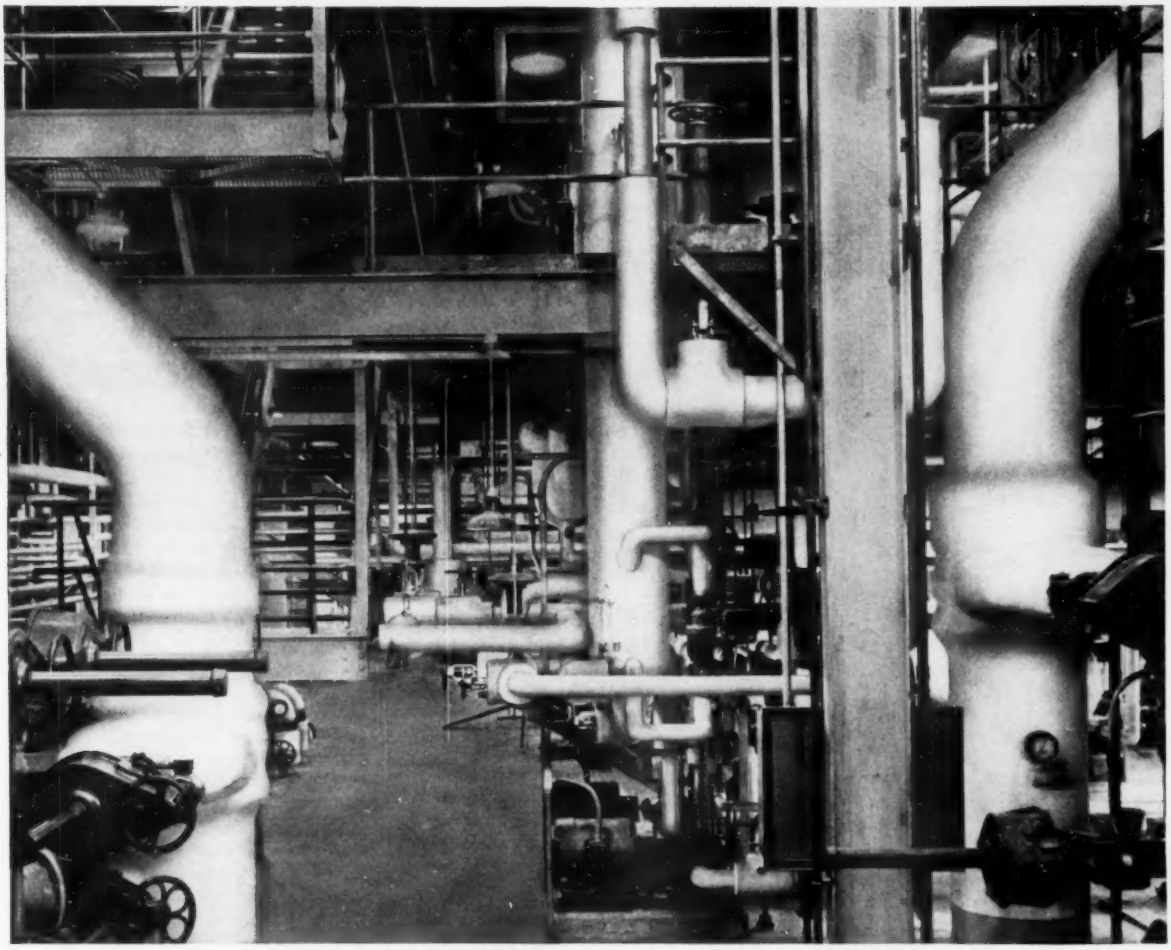
Coal looks to electric power as its principal customer and as its benefactor in energy utilization. The utilities have demonstrated that coal can be converted into a consumer energy that is widely used and has tremendous potentials.

What about coal and its availability? Here is an energy source with enormous reserves in most states. It now generates half the total electric power and two thirds of fuel-generated electric power. It supplies 85% of the utility fuel used east of the Mississippi.

The expanding power market will increase the demand for coal. When generation reaches 700 billion kwhr annually, coal needs will total 140 million tons if other power sources retain their present relationships to coal. But should use of other sources decrease, the load on coal will increase accordingly.

Looking further ahead, say to 1970,

Directions for ordering papers on p 230



Extraction unit and piping insulated with "Featherweight" 85% Magnesia. Sabrooke Plant, Rockford, Ill., of the Central Illinois Electric and Gas Co. Insulating Contractor: Standard Asbestos Manufacturing Co., Chicago

BEFORE YOU INSULATE, INVESTIGATE "Featherweight"® 85% MAGNESIA

The Sabrooke Plant of the Central Illinois Electric and Gas Co. (illustrated) is typical of the thousands of installations where "Featherweight" 85% Magnesia efficiently conserves heat.

"Featherweight" 85% Magnesia has for years—more than 60—effectively fulfilled the needs of schools, hospitals, hotels, apartment and office buildings, power plants, factories—wherever efficient conservation of heat is of importance.

"Featherweight" 85% Magnesia is more than efficient. It cannot burn and will not corrode because it is inorganic. It is light in weight and structurally stable. It is made in simplified thicknesses for pipe installations, so that each size and thickness will fit over or into another size and thickness. This is important where two layer thicknesses are desired and for reducing inventories.

If your company has an insulating problem, the chances are that "Featherweight" 85% Magnesia can help you save heat, save money! Your K&M distributor is an experienced applicator who will gladly give you more information, or write directly to us.

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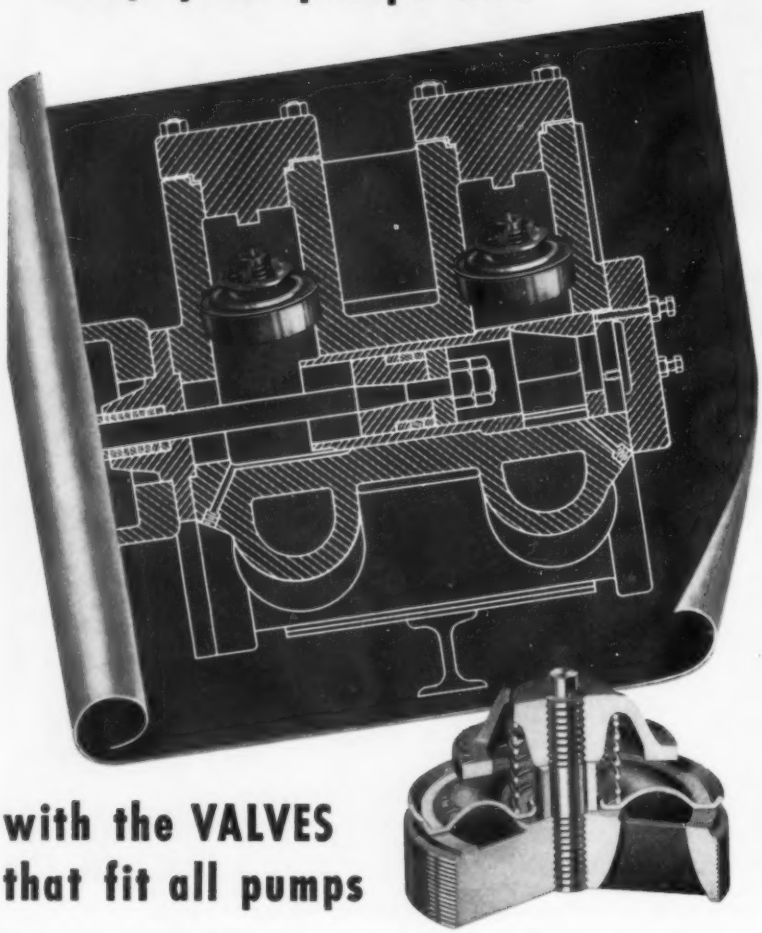

with the VALVES that fit all pumps

Your old reciprocating pumps can be rehabilitated or adapted to new and severe service by fitting them with DURABLA Pump Valve Units.

The patented corrosion-resistant, non-warping, pressed metal valve, making only "point contact" on the stud or sleeve, cannot bind or hang up on the guard stem. The open-type guard assures free flow of liquid and eliminates any possibility of spring clogging from hardening liquids.

DURABLA Pump Valves will operate freely under extremes of high or low temperature, with highly corrosive fluids, and in any position. They will handle vacuums of one micron or discharge pressures of thousands of pounds per square inch.

Standard equipment on many pumps, DURABLA Valve Units are made in fifteen sizes, designed to meet over 300 variations in installation requirements. They will fit any reciprocating pump, new or old.

A DURABLA engineer will be glad to help you work out a plant survey covering your valve requirements. Write for bulletin or engineering assistance.

DM-2

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More TECHNICAL BRIEFS

Begins on page 154

the power load may soar to 1.5 trillion kwhr, or even higher. At 0.7 lb per kwhr, 200 million tons of coal will be needed. With all the coal there is in the ground, it may look like there will be no difficulty in supplying as much as 100 million tons additional for power production in future years. This may be the case, but some coal production problems arise.

Mining capacity is overstated with coal needs from 5 to 10 years away. Currently it is in excess but it contains a substantial part that cannot be maintained for long without the return of a higher market level. In the future, producers will need the help of large buyers, like those in the power industry, to determine expected coal demands and the facilities needed to satisfy them.

Transportation is a particularly important item. Railroad freight, for example, represents about half the delivered cost of tonnage moved from northern West Virginia to Atlantic seaboard utilities. Freight costs increased one-third since 1948, more than offsetting the reduction in mine prices made possible through greater productivity. But a number of good answers are being worked out today.

During the last 30 years the amount of electric power generated by coal increased eight times but the total amount of coal consumed for this purpose increased at less than half that rate. Coal burned per kwhr dropped from about three to about one pound, and the tendency is still downward. *APC paper.*

TO OBTAIN COMPLETE TEXT

Material for these abstracts comes from the following sources unless otherwise stated. Order complete paper from source, not from POWER.

American Institute of Electrical Engineers, winter general meeting, Jan 18-26, Hotel Statler, New York, N. Y. Identified by initials AIEE and obtainable through AIEE, 33 W 39th St, New York 18, N. Y.

American Power Conference, annual meeting, Sherman Hotel, Chicago, Ill., Mar 24-26, 1954. Identified by initials APC. Obtainable in proceedings that may be purchased from R A Budenholzer, chairman, Illinois Institute of Technology, 3300 Federal St, Chicago 16, Ill.

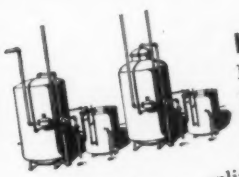
Twice the man he was!

The Elgin-Refinite man in your vicinity has a lot more for you than he had as an Elgin man or a Refinite man. The joining of Elgin and Refinite in October 1953 places at his finger tips the most comprehensive water conditioning service ever offered to industry.

He now has behind him the accumulated experience of two old-established firms. He has behind him an unequalled range of water conditioning equipment and methods. He has the ways and means to "make over" your raw water into a "finished product" having the exact characteristics you require.

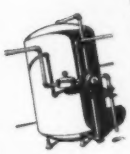
Do not underestimate the importance of this newly broadened service. Most water conditioning mistakes are a result of single track thinking by firms limited to one or two approaches to the problem. With complete freedom to choose the *best* way from *all* ways, Elgin-Refinite can solve your water conditioning problem the most effective and *economical* way.

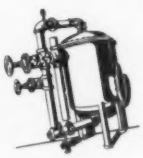
It would take many pages to cover the range of Elgin-Refinite service, but we briefly outline opposite how much more Elgin-Refinite has to offer in the four basic categories of water conditioning. To know what this broader service means to you, write us, or put your problem up to the Elgin-Refinite man.



Ion Exchange Equipment

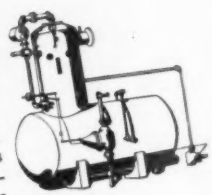
From sodium zeolite to complete deionization and silica removal, the Elgin-Refinite line is complete: The famous "Double-Check" zeolite softener . . . zeolite-alkalinity neutralization . . . split stream sodium and hydrogen zeolite softening with degasification . . . the Ultra-DeIonizer providing distilled water quality at a fraction of the cost.





Filtration in all phases

Diatomite filters . . . sand filters . . . activated carbon filters . . . anthrafilt filters for every use ranging from municipal water works and swimming pools to oil removal and many other applications.



Aeration, Degasification, and Deaeration

All types of equipment for removal of dissolved and entrained gases from water through degasification and aeration. A big efficiency gain is made by deaerating heaters which supply make-up water, preheated by exhaust steam, in which carbon dioxide is eliminated and oxygen is reduced to less than 0.005 cc per liter.

Lime-Soda, Coagulation, and Clarification

Whether it's simple clarification, cold lime soda or hot lime soda, Elgin-Refinite has the efficient answer. Hot lime followed by zeolite eliminates excess chemical dosage or after-treatment regardless of operating variations. Packaged and specially engineered equipment.

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The veteran RIC-WIL field supervisor and contractor join hands in a JOB WELL DONE. Expert field service is available on all RIC-WIL installations.

There is satisfaction in achievement . . . the knowledge that *BOTH* the supplier and the buyer have given their best . . . and the best in Prefabricated Insulated Piping for underground and overhead systems is RIC-WIL.

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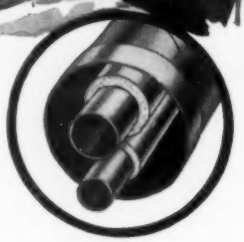

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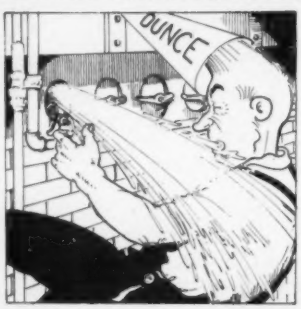


My Biggest Boner

► WE RUN A HYDROSTATIC TEST on our boilers after every cleaning. Some time back, we ran a hydrostatic and found several handholes in the lower waterwall header leaking. We tightened the plate nuts but the water wouldn't stop trickling out.

I told the fireman to drain the boiler so we could have a look at the gaskets and their seats. Someone called me into the engine room to do a small job. When I returned to the boiler room the gage glass was empty and the blowdown valves open.

Assuming the boiler empty, I closed the blowdown valves and loosened the handhole plate. Before I knew it, the plate slipped from my hand and hot water gushed from the hole, flooding the boiler room to a depth of several inches.

Checking back, we found the fireman opened the blowdown valves but left the drum vent closed. Just enough water drained from the boiler to empty the gage, but enough was left to give me a good scare and the fireman a nasty cleaning job.

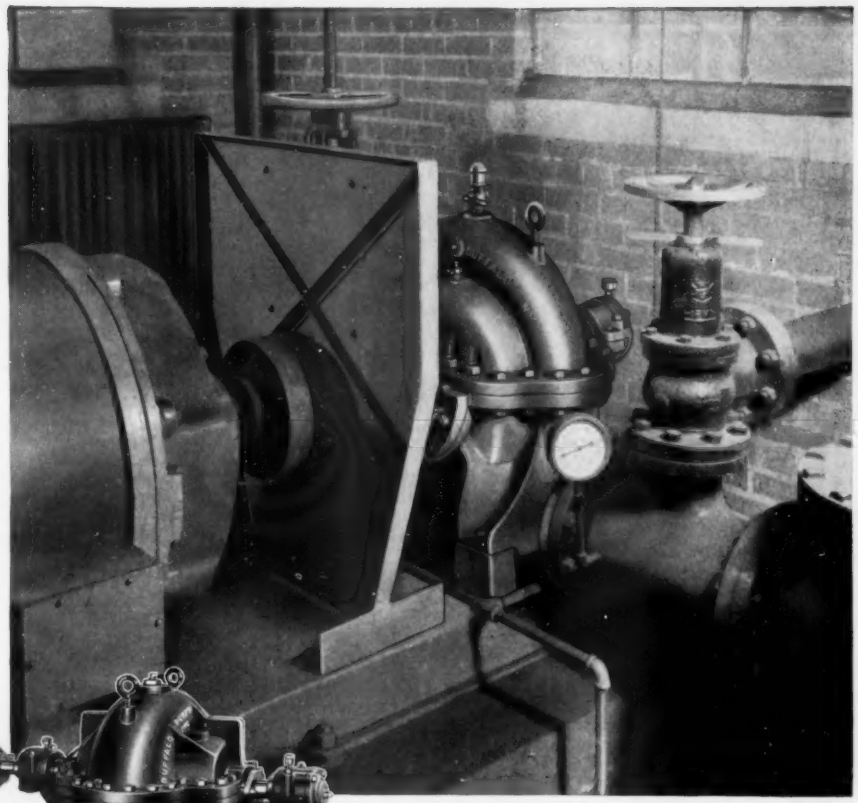
Of course, we were both in error. The fireman should have opened the drum vent before the blowdown valves and I should have checked the water level and vent before loosening the handhole plate.

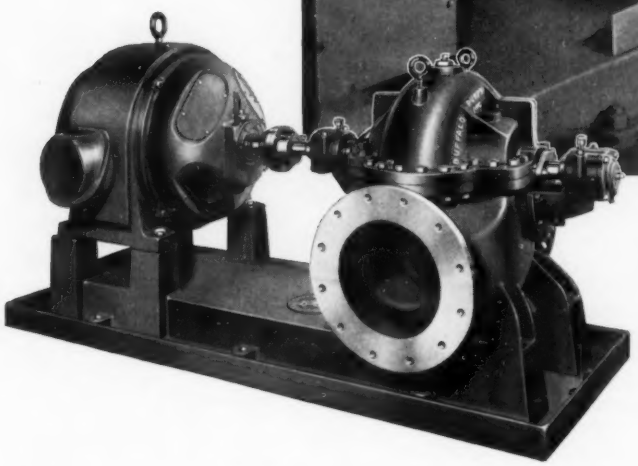
R V HARTMAN *St. Louis, Mo.*

• What is your "biggest boner"? We'll pay ten dollars for each one we publish.

Massachusetts Institute of Technology will offer a special summer course, Physics of Gaseous Electronic Devices, August 2 through 13. The program will deal entirely with the physics of electrical discharge and is designed to provide a background in the fundamentals of gas discharges for laboratory research personnel and design engineers.

HOW TO BE COST-WISE and WORRY-FREE in the PUMPS DEPARTMENT!





At left, **Buffalo Type SL Double Suction full ball bearing pump for general service in chemical plants.**

. . . SPECIFY PUMPS BY "BUFFALO"

When you install the "Buffalo" Pump recommended for your job, you can count on four things: (1) performance as rated, (2) easy maintenance, (3) lastingly high efficiency (therefore, economy of driving power) and (4) a unit that, with reasonable care, will last almost indefinitely. Briefly, you can expect to save money and headaches year after year.

A good example is the Type "SL" General Service Pump. A double suction pump with hydraulic balance, it has full ball bearing construction. Stuffing boxes are extra-deep. Water passages are large and simply formed for minimum resistance. And note how the rugged casing is split horizontally—you never have to disturb piping to inspect impeller and stuffing rings. Here is a pump that is universally popular in a wide variety of clear water uses in the 10 to 14,000 gpm range.

"Buffalo" builds a complete line of pumps for the chemical plant, fully described in Bulletin 982. Write for your free copy!

"Buffalo" PUMPS

BUFFALO PUMPS, INC.

488 BROADWAY BUFFALO, N. Y.

Subsidiary of Buffalo Forge Company

Canada Pumps, Ltd., Kitchener, Ont. Sales Representatives in all Principal Cities

A BETTER CENTRIFUGAL PUMP FOR EVERY LIQUID

Catawissa
PERFECT SEAL
Unions

HOT FORGED from solid, rectangular steel bars, designed and produced for dependable, long-life service under the severest piping conditions!

A TYPE FOR EVERY USE!
FOR ALL PRESSURES!
FOR ALL TEMPERATURES!

Standard & Double Extra Heavy
UNIONS

Available with screwed or socket weld ends. 3000-lb. sizes 1/8" to 3"; 6000-lb. sizes 1/8" to 2".

ORIFICE UNIONS

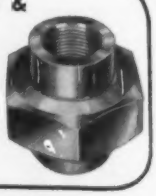
With screwed or socket weld ends. 3000-lb. and 6000-lb. service.

MALE & FEMALE UNIONS

With steel-to-steel, bronze-to-steel, stainless steel-to-steel or orifice seats. 3000-lb. service only.

FULL STAINLESS & FULL ALLOY STEEL UNIONS

With screwed or socket weld ends. 3000-lb. and 8000-lb. service.



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More POWER NEWS

Begins on page 152

As part of the four-day dedication ceremony, about 1000 of the nation's foremost hydraulicians met on May 20 to discuss, among other questions, adequate water supply for the U.S. Chairman of the program was Dr. Francis Dawson, Dean of the College of Engineering at the State University of Iowa. Appearing on the program also were Dr. Richard G Folsom, director and head of research of the engineering department of the University of Michigan; Gail A Hathaway, former president of the American Society of Civil Engineers and special assistant to the chief of engineers, Department of the Army; Dr Robert T Knapp, professor of hydraulics engineering at California Institute of Technology; Dr James W Daily, associate professor of hydraulics engineering, Massachusetts Institute of Technology; Professor Emeritus Aladar Hollander of California Institute of Technology; Clement P Lindner, chief engineer, South Atlantic Division of the Corps of Engineers; Professor Philip F Morgan, professor of sanitary engineering, State University of Iowa; Ireal A Winter, chief of the hydraulics machinery branch of the U.S. Bureau of Reclamation; and Dr George F Wislicenus, chairman of the mechanical engineering department, Johns Hopkins University.

Insulating

Continued from page 152

Pittsburgh Corning Corp, covers the sphere. Insulating blocks used are 2 in. thick, 12 in. wide and 18 in. long.

One reason for insulating the sphere was the need for maintaining a constant barometric pressure inside it. Any sudden change in interior pressure, caused by fluctuation of outdoor temperature, could exert hazardous stresses on the sphere, which is big enough to house an 18-story building.

In addition, the tremendous heating and cooling loads in the sphere require effective insulation to control heat losses in winter and heat gains in summer.

The blocks are impaled on 2.5-in. long steel pins welded to the side of the sphere on 9-in. centers. Two pins support each block. Metal clips hold the insulation to the pins.

Elementary information on the use and application of electric (wire-resistance type) strain gages will be the subject of two one-week special summer programs at Massachusetts Institute of Technology.

The two programs are:

Fundamentals of strain gage techniques, August 9 through 13; applications of strain gage techniques, August 16 through 20.

For further information and application blanks, write Summer Session Office, Room 7-103, MIT, Cambridge 39, Mass.

(*More Power News on page* 236)

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STEP AHEAD FASTER!
AS AN INDUSTRIAL ELECTRONICS TECHNICIAN

Turn your experience into a big, new better-paying career!
Day by day industrial plants are adding more electronic devices—for sorting, counting, checking, almost any control job you can name. Cash in on industry's great need for men who can keep these devices in top working order. Make more money, feel more secure, doing work that is second nature to you. With what you already know about electronics you have a long head start in a field just beginning to boom. GET INTO IT RIGHT NOW with the help of

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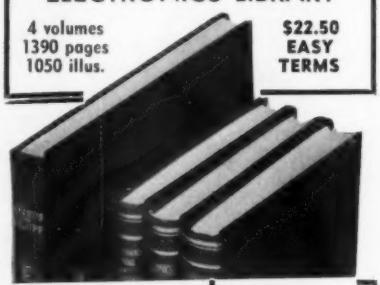

Here's the **practical** kind of information these 4 volumes show you:
—How to keep the plant's electronic equipment performing as it should
—How to locate and correct tube and circuit troubles quickly and easily
—How to install, service, and maintain even brand new equipment without being stumped by new circuits

No long sessions on math or theory! Instead you get: Clear explanations of how tubes and tube-operated circuits work in motor controls, welding controls, heat controls, etc. A complete manual that covers all maintenance procedures. A handbook of 433 industrial electronic circuits with each fully described. Troubleshooting charts, tested working methods, step-by-step directions — everything you need to start right now is here.

Contains:
Chute's Electronics in Industry
Miller's Maintenance Manual of Electronic Control
Markus & Zeluff's Handbook of Industrial Electronics Circuits
Henney & Fahnestock's Electron Tubes in Industry

Shows facts such as:
How to operate the vacuum-tube voltmeter
How to correct ignitor misfire
How to maintain light sources for photoelectric control
How to protect circuits of welding machines
How tubes serve in conveyor synchronization, color measurement, etc.
and hundreds more

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Send me the Practical Industrial Electronics Library for 10 days' examination on approval. In 10 days I will send $2.50, then $4.00 a month until $22.50 is paid. (A saving of $3.50 under the regular price of $26.00.) Otherwise I will return books postpaid.
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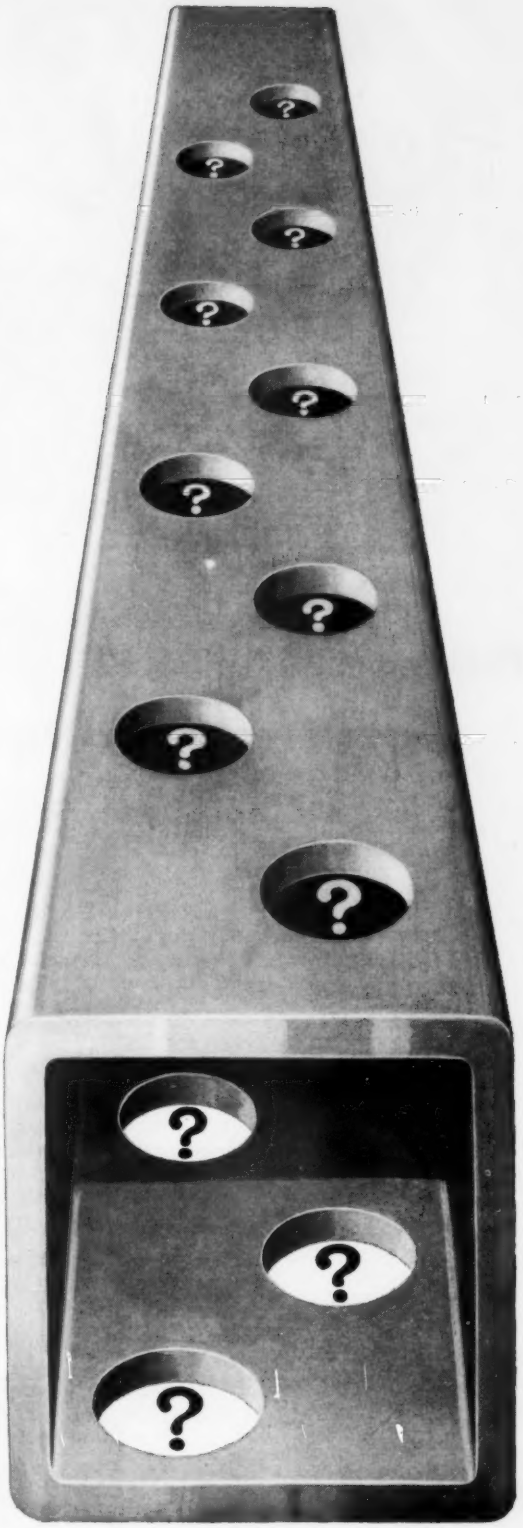
Why the holes in CHASE Bus Conductors?



They increase current-carrying capacity

By dissipating heat, the holes in Chase Square Ventilated Bus Conductor increase the current-carrying capacity up to 20%! Not only that . . . they lower costs by saving up to 36% in weight of copper when compared with flat rectangular bus bar!

How about strength? It stands to reason that square-constructed Chase Bus Conductors are stronger. The cross section configuration makes it mechanically rugged enough to handle heavy short circuit stresses . . . and allows longer unsupported lengths! In every way, Chase Square Ventilated Bus Conductor gives you better service! Find out more about it from the nearest Chase Branch listed below:

Chase

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MECHANICAL ELECTRICAL *20 Years of Engineered Efficiency in* **DUST COLLECTION SYSTEMS**

More POWER NEWS

Begins on page 152

Coming Events

July 13-15—Plant Maintenance Show and **Plant Maintenance Conference,** Pan-Pacific Auditorium, Los Angeles, Calif. For details write Clapp & Poliak Inc, 341 Madison Ave, New York, N. Y.

Sept 15-21—Instrument Society of America, First International Exposition and Congress, Commercial Museum, Philadelphia, Pa. Information from Richard Bimbach, managing director, 845 Ridge Ave, Pittsburgh 12, Pa.

Sept 28-Oct 1—1954 Iron & Steel Exposition, Cleveland Public Auditorium, Cleveland, Ohio. For details write AISE, 1010 Empire Bldg, Pittsburgh 22, Pa.

Oct 11-15—American Institute of Electrical Engineers, Fall General Meeting, Morrison Hotel, Chicago, Ill. Details from AIEE, 33 W 39th St, New York 18, N. Y.

Dec 2-7—21st National Exposition of Power and Mechanical Engineering, Commercial Museum, Philadelphia. For information write International Exposition Co, 480 Lexington Ave, New York 17, N. Y., Charles F Roth, manager.

Polyester film offers unusual balance of properties

► THE NEW "MYLAR" polyester film exhibits properties that surpass those long considered "ideal" for flexible plastics and insulating materials, according to the manufacturer, E I du-Pont deNemours & Co, Inc.

Among these are insensitivity to moisture; resistance to solvent and chemical attack; high dielectric strength; operating temperature range from –60 to 150 C, without sacrifice in strength.

Uses proposed for the new film include electrical insulation, industrial laminations, drum liners, pressure sensitive tapes.

For more information, write to the Du Pont Company's Film Department, Wilmington 98, Delaware.

New plant increases Bogue facilities by 30%

► AS PART OF AN EXTENSIVE PROGRAM of continuing diversification, Bogue Electric Manufacturing Co recently opened a new addition to their plant in Paterson, N. J.

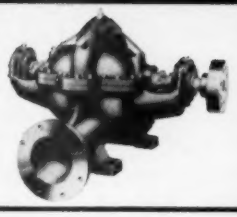
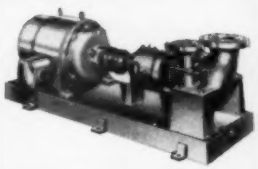
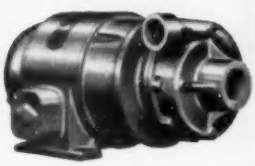
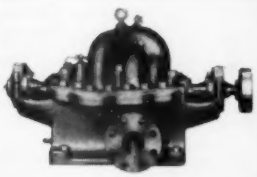
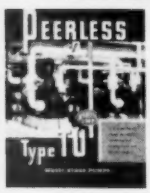
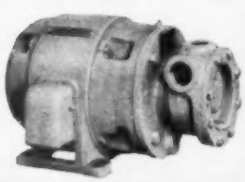
Principal speaker was Vice Admiral John E Gingrich, Chief of the Office of Naval Materiel. His speech was titled "Teamwork and Efficiency in Industry and the Navy."

(*More Power News on page* 238)

5 Peerless Pump Designs

that squarely meet every WATER HANDLING REQUIREMENT

PEERLESS PUMPS

THESE ARE THE *Pumps*		ASK FOR *FREE* ENGINEERING BULLETINS
TYPE A AND TYPE AS GENERAL PURPOSE PUMPS Use these pumps in the widest range of water handling services. Single stage, horizontal split case design. Mechanical shaft seal construction available in sizes up to 4" (Type AS). Heads: up to 300 ft.; capacities up to 70,000 gpm.		Ask FOR BULLETIN B-1300 & B-1350
TYPE PR AND TYPE PRS HIGH TEMPERATURE, HIGH PRESSURE PUMPS Horizontal center-line-mount pumps with packing gland or mechanical shaft seal construction. End or top suction designs. Heavy duty pumps for heads up to 675 ft. Capacities: up to 1000 gpm and temperatures up to 850°F.		Ask FOR BULLETIN B-1605
TYPE PE AND TYPE PB END-SUCTION PUMPS America's broadest line of economical, general purpose pumps. Horsepower range from ¼ to 150. Head range to 260 ft. Capacities up to 5500 gpm. Easy to buy, apply, install and maintain. Tens of thousands in use.		Ask FOR BULLETIN B-2300
TYPE TU AND TYPE TUT MULTI-STAGE PUMPS 2,3,4 and 5-stage designs for supplying, circulating and boosting water and other liquids in moderate capacities against medium and high heads. Durable and dependable in operation. Heads up to 1660 feet; capacities up to 3000 gpm.		 Ask FOR BULLETIN B-1400
TYPE TVE AND TYPE TVB TURBINE VANE PUMPS For pumping hot and cold, clear and vaporous liquids in small capacities against high heads. Widely used throughout industry for water boosting, circulating, transferring. Easy to install and maintain. Capacities: up to 58 gpm; heads up to 800 feet.		Ask FOR BULLETIN B-2205

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- ☐ Type AS Bulletin B-1350
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in 3 types to suit any requirements

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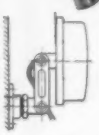
2 **Wall Mounted Dial Thermometer** with flexible connecting armor. Case adjustable to easy reading position.



3 **Flush Mounted Dial Thermometer** for panel mounting with flexible connecting armor.

All three types have a full 4½" dial face.

for accuracy: Mercury actuated . . . Fully Compensated by Invar Compensaton. Guaranteed Accurate 1 scale division.

for angularity: Can be adjusted to most readable position at any angle desired.

for readability: Bold Black Numbers . . . 11" of scale Reading Dial face can always be placed in easiest readable position.

for interchangeability: Always specify "PALMER" Separable sockets as they are interchangeable for Dial or Industrial type Thermometers.

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PALMER
THERMOMETERS, INC.
Norwood Ave., Cincinnati 17, Ohio
Mfrs. of Industrial Laboratory Recording and Dial Thermometers

More POWER NEWS

Begins on page 152

Trane Co dedicates new research laboratory

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In the laboratory, temperatures in any part of the world can be duplicated in order to pre-test air conditioning, heating, ventilating or heat transfer equipment for use anywhere from the Arctic regions to the Equator.

Intensive studies already outlined range from basic flow studies on varying types of coils to correlation of factors affecting condensing and evaporating coefficients of refrigerants, and from coil performance under severe frosting conditions to high temperatures.

Many other projects are under way in laboratory rooms where temperatures can range from −65 to +2500 F.

Instruments are maintained at highly accurate levels by frequent comparison with master standards of temperature and pressure in the Instrument Calibration Room. Here, for example, is a high-precision water manometer that is accurate to 0.001 in. of water; thermometers that measure temperature within 0.05 deg.

Speaking at the dedication, the Honorable Robert LeBaron, Assistant to the Secretary of Defense, urged "a Trane program to develop atomic power and other peace-time applications of atomic fission as rapidly as possible."

(*More Power News on page* 240)

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In 1949, the company added another large pump utilizing Ni-Resist. Then in 1951, Ni-Resist was specified in four new 35,000 GPM units for the South Street Station, a quarter mile upstream. And in 1953, Narragansett engineers specified Ni-Resist columns and discharge heads for two smaller pumps.

This is typical . . . for in corrosive and erosive seaboard waters, Ni-Resist renders efficient, economical performance.

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Full 4½" dial face. Stem can be placed at any angle and case can be rotated to any readable position.

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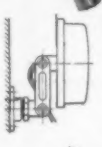

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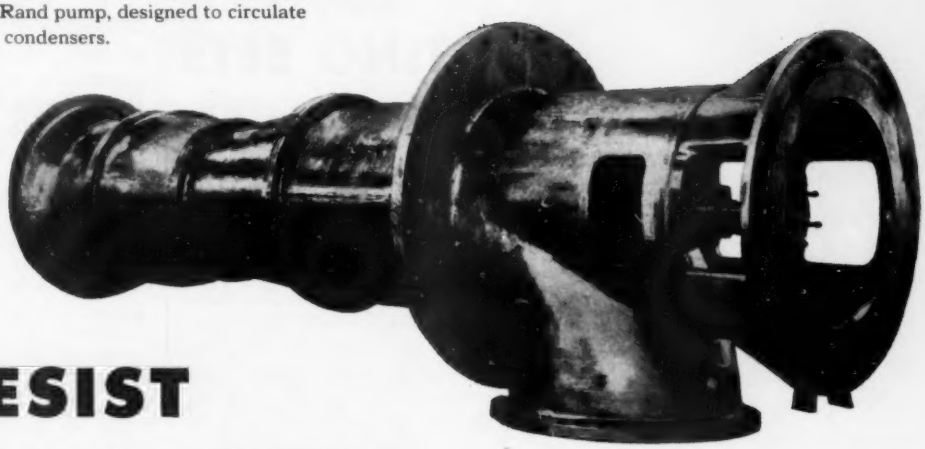
Big Gun In War On Corrosion. The use of Ni-Resist is accelerating the trend to swing away from ordinary cast iron components for circulating pumps and valves handling coolants of a corrosive nature. Shown here are the Ni-Resist casing, outer column and discharge head for an Ingersoll-Rand pump, designed to circulate sea water for cooling condensers.



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In 1949, the company added another large pump utilizing Ni-Resist. Then in 1951, Ni-Resist was specified in four new 35,000 GPM units for the South Street Station, a quarter mile upstream. And in 1953, Narragansett engineers specified Ni-Resist columns and discharge heads for two smaller pumps.

This is typical . . . for in corrosive and erosive seaboard waters, Ni-Resist renders efficient, economical performance.

Moderate in cost . . . readily machinable . . . resistant to heat as well as metal-to-metal wear . . . Ni-Resist is the answer to many perplexing problems and can probably save you money and worry.

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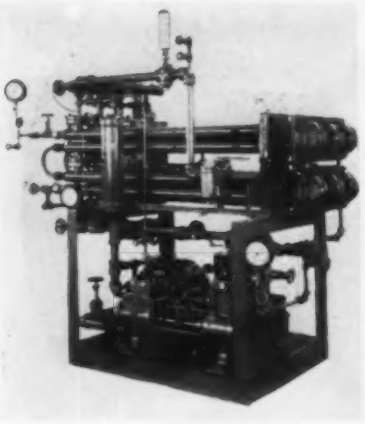
Custom Built



A composite Pump and Heater Set, consisting of one Steam-Driven Duplex Pump and one Electric-Driven Rotary Pump, with Heater Units mounted above the Pumps. Complete with Pressure and Temperature Controls. Capacity 4,000 pounds per hour of bunker C fuel oil against 300 P.S.I.

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Easy to set on face of switch — unaffected by dust, dirt or corrosion — no pitting or sticking.

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More POWER NEWS

Begins on page 152

To present ventilating and air conditioning papers at Columbia

► As its contribution to the 1954 bicentennial celebration of Columbia University, the Department of Mechanical Engineering has arranged a Technology-Jubilee Week program, Sept 13 to 17.

Tentative schedule:
Sept 13-15: Conference on refrigeration and air conditioning. Presentation of papers and lectures under joint auspices of TRRF, ASME, ASRE, and ASHVE.
Sept. 15-17: Conference on industrial ventilation, jointly sponsored by Dept of Mechanical Engineering, Columbia University, and Division of Industrial Hygiene, New York State Dept of Labor.

Sessions will be held in Pupin Hall at the University, and registration is limited. Direct inquiries to Prof Carl F Kayan, Dept of Mech Eng, Columbia University, New York 27, N. Y.

GE dedicates medium transformer plant at Rome

► General Electric Co's new $25,000,000 plant at Rome, Ga., was officially opened and dedicated May 11. This new plant will mass-produce power transformers rated 501 to 10,000 kva, 69,000 volts and below.

With nearly a half mile of conveyors, new processes and new machinery, the company claims a 1/3 reduction in the manufacturing cycle for this size of transformers. The time saving is mainly accomplished through mechanized handling of materials and parts.

Mechanization is a radical departure from the job-shop methods employed in the past in making such large units, the company states. However, highly technical skills are still a necessary part of operations.

David B Lawton, plant manager, says the new facility will enable GE to supply the nation's expanding industries with transformers faster than ever.

More FREE BULLETINS

Begins on page 167

16 **Current-limiting reactors.** Type MSP, for installation of industrial branch circuits. Construction and operational characteristics. Bulletin B-5918, Westinghouse Electric Corp, PO Box 2099, Pittsburgh 30, Pa.

17 **Low voltage switchgear.** Photos, diagrams, specs and applications for laying out switchgear. Two-color, 36-page bulletin 200, Continental Electric Equipment Company, PO Box 1055, Cincinnati 1, Ohio.

18 **Union relays** for general industrial applications. Photos, operation and construction data. Two-color, 4-page bulletin 1002, Union Switch & Signal, Div of Westinghouse Air Brake Co, Pittsburgh 18, Pa.

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Excellent corrosion resistance to corrosive or contaminated sea water.

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Unaffected by chlorination sufficient to combat biofouling.

Highly resistant to steam and steam condensate.

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Superior resistance to pollution from paper mill wastes.

Gives long life under conditions too severe for ordinary condenser tube alloys.

To strike a sound balance between first cost of condenser tubes, and long-range operating efficiency and maintenance costs, it's good economics to consider Bridgeport Duronze IV (Arsenical Aluminum Bronze). These condenser tubes give long service life and reduce shutdown time.

Bridgeport Duronze IV is just one of the many Bridgeport condenser tube alloys made to ASTM Standards and to meet every type of operating requirement. Bridgeport's Corrosion Laboratory will be glad to work with you in selecting the alloy best suited to your own operating conditions.

Write for Bridgeport Condenser and Heat Exchanger Tube Handbook —which contains much useful information on condenser tubes and corrosion problems.

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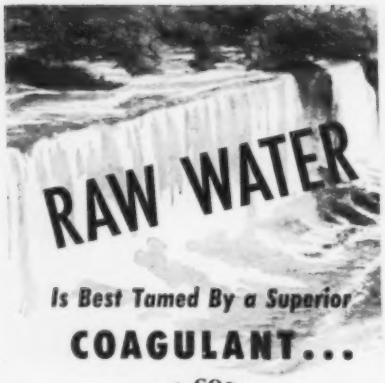

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Whatever your specific water treatment problem may be, you can figure on Ferri-Floc to do the job adequately and efficiently. A partially hydrated ferric sulphate, Ferri-Floc is a stable, free flowing, granular salt which can be fed with few modifications through any standard dry feed equipment. It is only mildly hygroscopic, thereby permitting easy and safe handling as well as storage in closed hoppers over long periods of time.

You Can Expect These Advantages:

- Rapid Floc Formation
- Ease of operation
- PH correction
- Bacterial removal
- Taste and odor control
- Manganese and Silical removal
- Color removal
- Turbidity removal
- Softening
- Economy

Water Treatment
Coagulation of surface or well waters. Aids taste and odor control. Effective in lime soda-ash softening. Adaptable to treatment of nearly all industrial water or wastes.

Sewage Treatment
Coagulation of wide PH range. Efficient operation regardless of rapid variations of raw sewage. Effective for conditioning the sludge prior to vacuum filtration or drying on sand beds.

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SULPHUR-DIOXIDE Is effectively used for dechlorination in water treatment and to remove objectionable odors remaining after purification.

COPPER SULPHATE Will control about 90% of the microorganisms normally encountered in water treatment plants more economically than any other chemical.

Samples, Specifications and Detailed Information on Request.

TENNESSEE CORPORATION

617-29 Grant Building, Atlanta, Georgia

More FREE BULLETINS

Begins on page 167

★ **High-voltage power supplies** and magnetic amplifier regulated units. Photos and specs. Four-page bulletin MA154. ★Request direct on letterhead to Perkins Engineering Corporation, 345 Kansas St, El Segundo, Calif.

19 **Temperature controls,** Models V-1C and V-1X, for high temperature safety alarms and cut-outs to 1800 F. Photos and specs. Two-page bulletin 102, Burling Instrument Co, Inc, 16 River Rd, Chatham, N. J.

25 **Voltage regulators** for rural areas are discussed in 20-page booklet B-6054. Deals with regulators in a non-technical way and includes theory and principles. Westinghouse Electric Corp, PO Box 2099, Pittsburgh 30, Pa.

26 **Air circuit breakers** are described in four-page bulletin 5107-DR-1. Includes features, specs, and photos of types KA, KB, KC and LG *(Urelite)*. I-T-E Circuit Breaker Co, 19th & Hamilton Sts, Philadelphia 30, Pa.

27 **Pyrometer accessory catalog** is a working data file using tables and examples. Enables determination of types of thermocouples and pyrometers needed. Illustrated. West Instrument Corp, 525 Noble St, Chicago 22, Ill.

28 **Filter control system** for centralized filter operation and automatic backwashing. Four-page, two-color, illustrated bulletin 480-LI. Builders-Providence, Inc, 345 Harris Ave, Providence 1, R. I.

MECHANICAL TRANSMISSION

29 **Variable pitch sheaves,** special drives illustrated in 8-page bulletin. Engineering data on 3- to 8-in. OD sheaves in seven sizes. Capacities from ¼ to 15 hp. Speed Selector, Inc, 118-V Noble St, Cleveland 13, Ohio.

ELECTRICAL EQUIPMENT

30 **Glass-silicone laminate** for use as transformer spacer bars and barrier sheets. Four-page, two-color illustrated bulletin. Barrier sheets available in 36 x 72 in. sizes and smaller. Thicknesses .020 to .045 in. Formica Co, 4614 Spring Grove Ave, Cincinnati 32, O.

31 **pH Electrodes** and electrodes for measuring *Redox* potentials described in 20-page, illustrated catalog EN-S5. Includes chemicals for electrode servicing and auxiliary equipment such as clamps, holders and thermometers. Leeds & Northrup Co, 4907 Stenton Ave, Philadelphia 44, Pa.

HEAT EXCHANGERS

37 **Heat transfer** industrial designing, engineering and fabrication are discussed in illustrated, 24-page booklet by the Lummus Co, 385 Madison Ave, New York 17, N. Y.

38 **Heat exchanger tubes.** 24-page illustrated booklet "Alcoa Aluminum Heat Exchanger Tubes." Catalytic cracking, desulfurization, ammonia recovery, nitric acid handling and hydrocyanic condensers are discussed and pictured. Aluminum Co of America, 728 Alcoa Bldg, Pittsburgh 19, Pa.

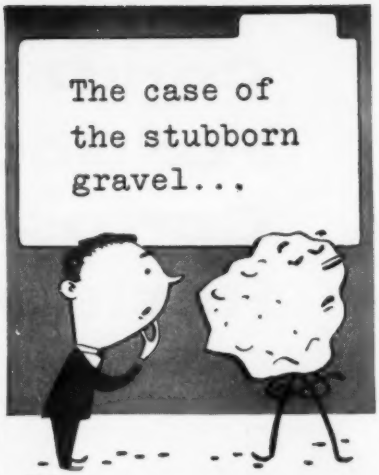
INSULATION

39 **Installation techniques** and construction features discussed in 4-page illustrated folder dealing with multiple aluminum insulation for 12, 16, 20 and 24 inch centers. Infra Insulation, Inc, 525 Broadway, New York 12, N. Y.

40 **Insulating varnishes,** catalog containing "how to" features, complete data on new and well-established types of varnishes, application instructions and tables. Irvington Varnish and Insulator, Div Minnesota Mining and Mfg Co, 6 Argyle Ter, Irvington 11, N. J.

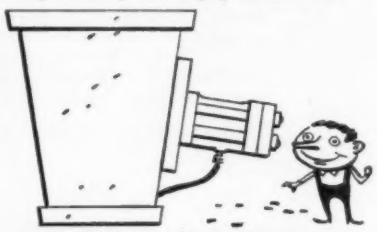
MAINTENANCE AND SAFETY

43 **Lifting jacks,** including ratchet, screw and hydraulic types, are explained in 40-page illustrated manual



Yes, believe it or not, chaos really reigned in this case of a Washington gravel plant . . . all because of a pile of stubborn gravel.

It bridged . . . it arched . . . it plugged . . . and generally tied up production.



After we got the facts on the case, we recommended a CLEVELAND vibrator, and in nothing flat that stubborn gravel was moving continuously and smoothly.

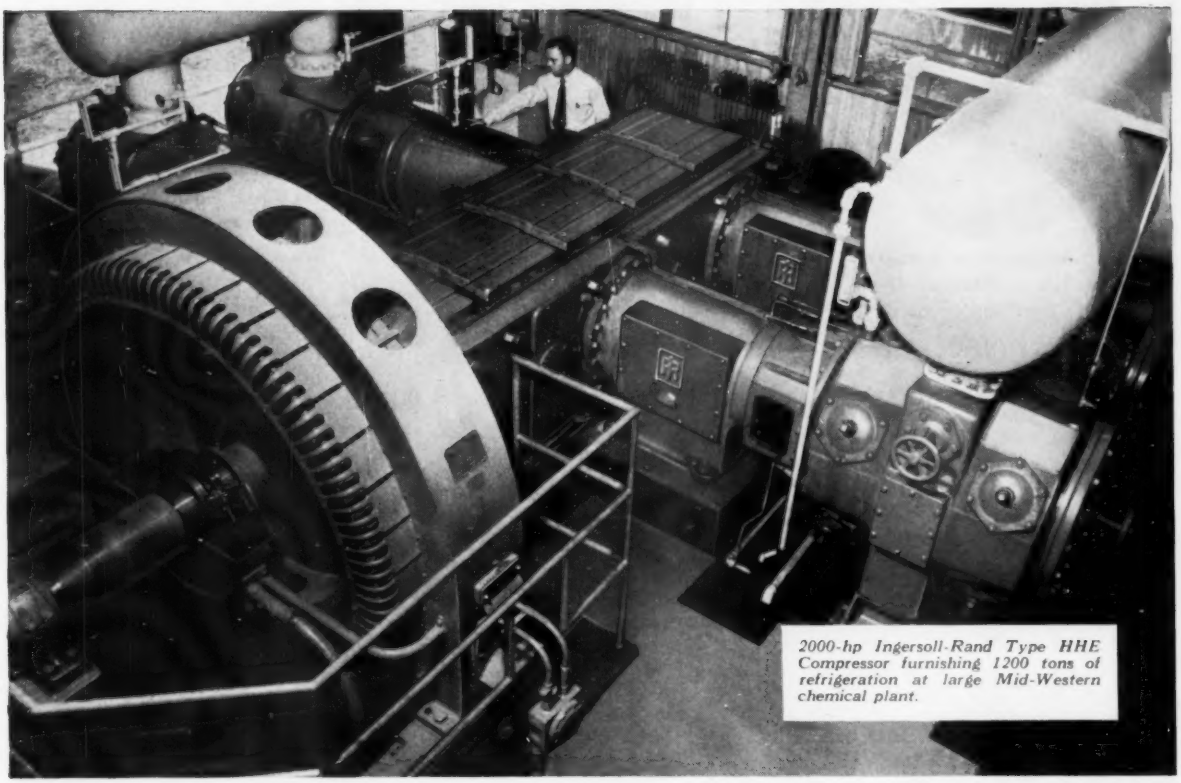
Tell us your materials handling problem, or ask for our detailed literature.

AIR *and* ELECTRIC

2824 Clinton Avenue • Cleveland 13, Ohio

5 YEARS OF CONTINUOUS SERVICE

with practically **No Maintenance**



2000-hp Ingersoll-Rand Type HHE Compressor furnishing 1200 tons of refrigeration at large Mid-Western chemical plant.

2000-hp ammonia compressor gives outstanding performance at large chemical plant

Installed in 1949 this heavy-duty Ingersoll-Rand compressor has been in continuous service supplying 1200 tons of refrigeration for a large Mid-Western chemical plant. Driven by a 2000-hp synchronous motor, it compresses ammonia in two stages from 11 psig to 215 psig. During these five years' operation there has been practically no maintenance or replacement of parts.

Based on this outstanding performance record, the company has recently installed a 3000-hp air compressor of the same fundamental design, thus taking advantage of the interchangeability of most of the wearing parts. 1-50

If you have processes calling for compression or evacuation of air or gas you can surely benefit from Ingersoll-Rand's experience in designing and building the world's most complete line of reciprocating and centrifugal compressors. Your I-R engineer is well qualified to give you expert assistance, no matter what the gas, pressure, temperature or process.

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For efficient, uniform combustion just switch to Enos or Enoco, Indiana's finest stoker coals.

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310 South Michigan Avenue • Chicago 4, Illinois

SALES

in the power field

If you sell a power-field product, you may have profitable use for POWER's new 1954 "Directory of Manufacturers' Agents Serving the Power Field."

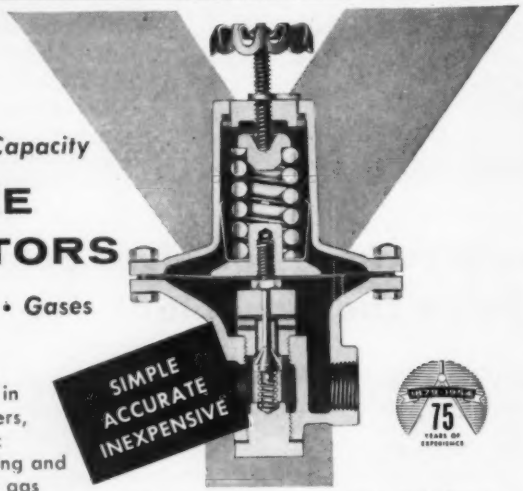
See page 252

FOSTER Y-TYPE

Small Bore — Small Capacity

PRESSURE REGULATORS

for Steam • Liquids • Gases



Thousands of these versatile valves are in service on unit heaters, cookers, and plastic presses; glass blowing and bottling machinery; gas or oil firing; sterilizers and vulcanizers; instrument control; and low pressure heating.

These valves are unusually sensitive to slight variations in reduced pressure, and give close regulation. Yet they are so simply designed that they present no maintenance problems.

They are built for initial pressures as high as 3000 P.S.I. for air and liquids, 300 P.S.I. for steam; for reduced pressures ranging from ounces to 250 P.S.I. Sizes ¼" through ¾" depending on type. Available in stainless steel alloys. Write for Bulletin Y-101.

FOSTER ENGINEERING COMPANY

835 LEHIGH AVENUE UNION, N. J.

AUTOMATIC VALVES • SAFETY VALVES • FLOW TUBES

More FREE BULLETINS

Begins on page 167

in color. Includes jacks from 3- to 100-ton capacities and gives specs for each. Catalog 204, Duff-Norton Mfg Co, PO Box 1889, Pittsburgh 30, Pa.

44 **Tank cleaning** by chemical solvents, 4-page, 2-color, illustrated brochure. Charts and descriptions. Dowell Inc, Box 536, Tulsa 1, Okla.

METALS AND ALLOYS

50 **Calculating wheel,** three-color, provides engineering characteristics of castings in four major classifications: general, heat-, corrosion- and wear-resisting. Meehanite Metal Corp, 714 North Ave, New Rochelle, N. Y.

51 **Heat-resistant** and corrosion-resistant alloy castings in industry are described in 48-page bulletin A-141. Charts and tables of composition. The International Nickel Co, 67 Wall St, New York 5, N. Y.

METERS AND INSTRUMENTS

54 **Recording controller** featuring continuous standardization through magnetic standard. Bulletin GED-2100, 20-pages, illustrated. General Electric Co, Schenectady 5, N. Y.

PIPING, VALVES, FITTINGS

58 **Instrument tube fittings,** corrosion resistant type. Single-sheet bulletin L-9306. Sectional views, dimensions. Dekoron Products Div, Samuel Moore & Co, Mantua, Ohio.

PUMPS

63 **Centrifugal pumps,** type UNB two-stage, designed for working pressures up to 400 psi and capacities up to 1300 gpm. Photo and sectional drawing. Single-sheet bulletin W-318-S27, Sales Promotion Dept, Worthington Corp, Harrison, N. J.

64 **Motorpump selection,** "how-to" booklet. Briefly describes what a centrifugal pump is and how it operates. Sixteen-page bulletin, Form 7123. Ingersoll-Rand Co, Cameron Pump Div, 11 Broadway, New York 4, N. Y.

APPOINTMENTS

Corporation executive changes

Westinghouse Electric Corp: Donald C Burnham, vice-president in charge of manufacturing, succeeding T I Phillips, retiring; Walter J Maytham, Dale McFeatters and Otis O Rae, vice-presidents. **American Air Filter Co, Inc:** C A Pickett, vice-president of Illinois Engineering Co, a subsidiary. **Borg-Warner Corp:** Robert G Allen, president and general manager of Pesco Products division; Judson S Sayre, president and general manager of Norge division. **Vitro Corp of America:** Eugene B Hotchkiss, vice-president. **The Foxboro Co:** W W Frymoyer, vice-president.

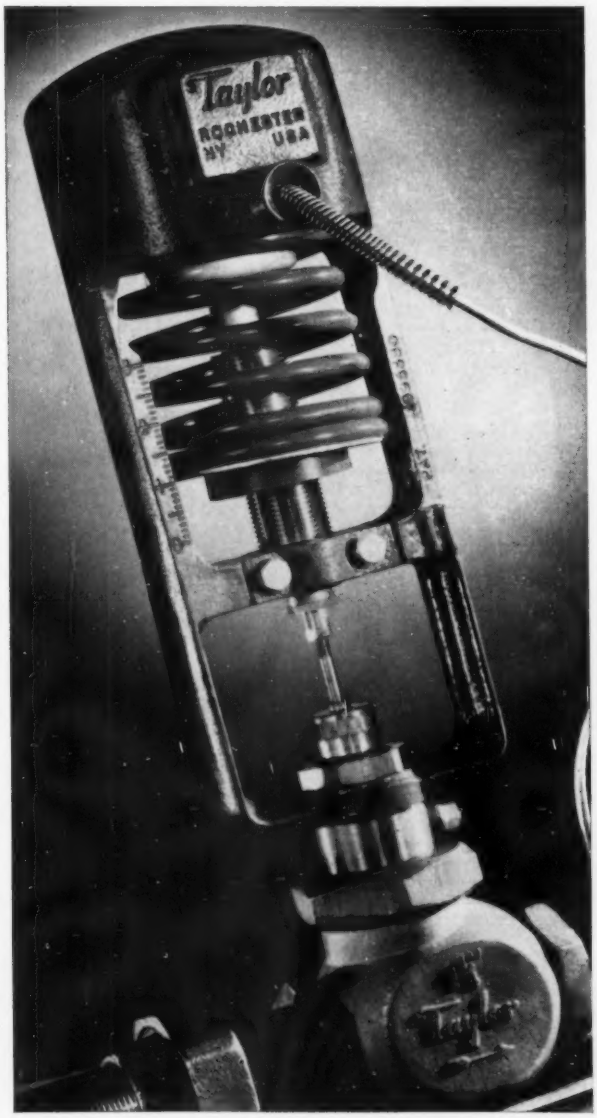
Operations executive changes

Allis-Chalmers Manufacturing Co: David A Griffith, general manager of Pittsburgh works; Fred W Bush, assistant to vice-president in charge of transformer and switchgear equipment. **Worthington Corp:** E J Tribble, assistant vice-president in charge of manufacturing; A M Tullo, works manager of Harrison plant; L E Hammer, works manager of Wellsville plant. **Borg-Warner Corp:** Fred Gombert, Norge Heat product manager. **Chester Cable Corp:** John Lachmann, executive technical director.

(*Continued on page 246*)

Don't let us sell you a Fulscope® Controller...

for applications where the Taylor Self-Acting Temperature Controller will do the job!



OUR enterprising management would like us to sell more FULSCOPE Controllers. It's a bigger sale. But your Taylor Field Engineer will tell you that there are many applications where the simple, dependable Self-Acting Temperature Controller will do the job to everyone's satisfaction.

Typical of the jobs that this reliable controller will take in its stride are: hot water tanks; diesel engine water jackets; compressor water jackets; lubricating oil coolers.

It requires no auxiliary air supply for its operation. Double-seated valves are available in sizes up to 2″; single-seated composition disc types up to 1″. There are numerous standard temperature ranges between 10 and 340° F., and semi-standard ranges within limits of 135 and 610° F.

Write for Catalog 36R, or ask your Taylor Field Engineer to tell you about this and other instruments particularly adaptable for the power industry. Taylor Instrument Companies, Rochester, New York, and Toronto, Canada. *Instruments for indicating, recording and controlling temperature, pressure, flow, liquid level, speed, density, load and humidity.*

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MEAN
ACCURACY FIRST
IN HOME AND INDUSTRY

Combined experience of
Two Hundred and Fifty Years
In the manufacture of Boilers

JOHN THOMPSON LIMITED
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Established 1824

and

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Established 1834

have amalgamated to form a new Company to be known as

JOHN THOMPSON-LEONARD LTD.

This brings together Leonards, a firm long held in high esteem throughout Canada, and Thompsons, one of the largest manufacturers in Europe of shell boilers, and one of the World's leading designers and manufacturers of water tube steam generators and auxiliary equipment.

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Cut Fuel and Steam Costs with...

Babbitt
Adjustable
SPROCKET RIM
with Chain Guide

Plan your piping layout for most efficient and economical distribution of steam — place valves where they logically belong, without costly detours to bring overhead piping to floor level. Every overhead valve, wherever placed, is in easy reach with low-cost Babbitt Adjustable Sprocket Rim with Chain Guide. Save steam, fuel and other costs!

- **Reduces piping costs**
- **Fits all valve wheels**
- **First cost is last cost**

Range of 10 adjustable sizes fits all valve wheels from 2 to 30 inches diameter, with rising or non-rising stems. Only four simple, quickly-assembled parts.

Call your Industrial Distributor. He carries complete stocks. Or write for descriptive folder and prices.

Babbitt STEAM SPECIALTY CO.
2 BABBITT SQUARE, NEW BEDFORD, MASS.

More APPOINTMENTS

Begins on page 244

Engineer changes

Babcock & Wilcox Co: P R Grossman, chief research engineer. **Allis-Chalmers Manufacturing Co,** general machinery division: R C Allen, director of mechanical engineering; L J Linde, director of electrical engineering.

New sales managers

Robertshaw-Fulton Controls Co: Lawrence C Connolly, Boston office of Fielden Instrument division. **Babcock & Wilcox Co:** Henry W Doctor, Cincinnati district office of tubular products division.

Recent purchases, mergers

Walter Kidde & Co, Inc: all assets of Alertronic Corp. **American Car & Foundry Co:** contracted to purchase W-K-M Co of Houston, Texas. **Worthington Corp,** through its subsidiary Electric Machinery Manufacturing Co: acquisition of Mullenbach Electrical Mfg Co of Los Angeles.

Recent moves

Dravo Corp: new Southwest office at 1615 Blodgett Ave, Houston 4, Texas. **The Trane Co:** Little Rock, Ark. office now at Room 718, Pyramid Building. **Bailey Meter Co:** Philadelphia district office to larger quarters at 29 Bala Ave, Bala Cynwyd, Pa. **Detroit Stoker Co:** Chicago district office to 222 W Adams St, Room 1415, Chicago 6, Ill.

Institute elections

Air Conditioning and Refrigeration Institute: A J De Fino, president; James Emmet Jr, vice-president. **The Water Conditioning Foundation:** Earl C Reynolds, president; James Lindsay, vice-president.

Awards

Edith Clarke: Society of Women Engineers award for outstanding contributions in field of generation and transmission of electricity. **Samuel B Morris:** distinguished service award of the American Public Power Association. **Thomas E Eagan:** Joseph S Seaman Gold Medal by the American Foundrymen's Society. **Walter E Sicha:** Wm H McFadden Gold Medal by American Foundrymen's Society.

Retirements

Robert A Neal: Pacific Coast vice-president of Westinghouse Electric Corp, after 44 yrs service. **L R Douglass:** director of power of Boulder Canyon project. **Prentiss M Brown,** chairman of the board, and **Arthur S Albright,** executive vice-president, of The Detroit Edison Co.

Obituaries

Henry Duckworth, 82, retired vice-president for Norton Co, April 1. **H F Canaan,** director of turbine building section for J M Voith Co in Heidenheim (Brenz), Germany, April 12.

F W Wilkening, founder and chairman of board of Wilkening Mfg Co, April 22.

Harry M Frecker, 50, manager of commodity sales, mechanical goods division of United States Rubber Co, May 3.

Charles R Crane II, 61, vice-president and director of Crane Co, May 8.

Have you read *all* of these lusty, laughable, freewheeling stories about Marmaduke?

Marmy's ingenious engineering feats are always plausible, even if his consumption of Sandpaper Gin seems impossible!

Now you can have 21 of Marmaduke Surfaceblow's most amusing tales—handsomely hard-cover bound for only $1.

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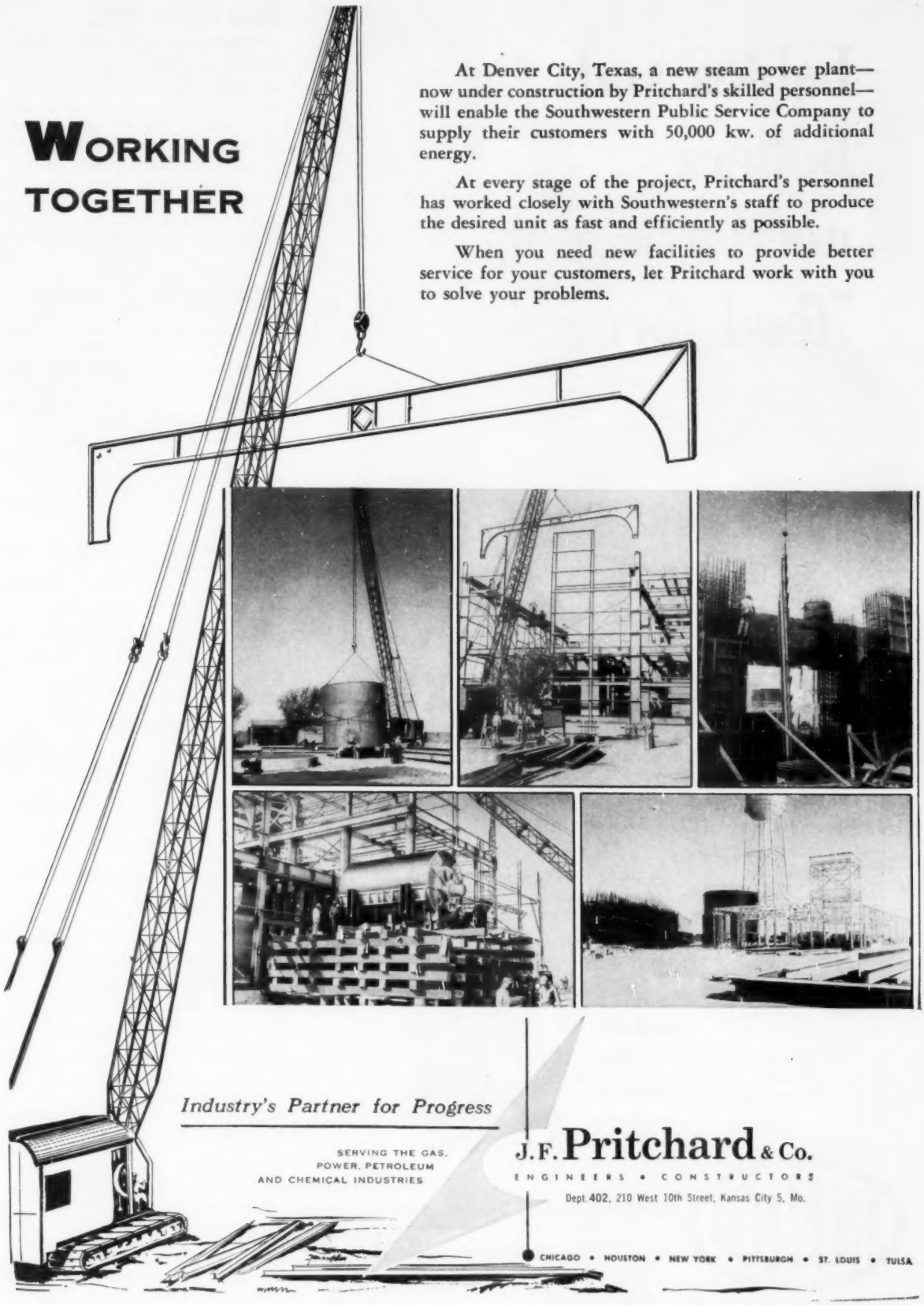
At Denver City, Texas, a new steam power plant—now under construction by Pritchard's skilled personnel—will enable the Southwestern Public Service Company to supply their customers with 50,000 kw. of additional energy.

At every stage of the project, Pritchard's personnel has worked closely with Southwestern's staff to produce the desired unit as fast and efficiently as possible.

When you need new facilities to provide better service for your customers, let Pritchard work with you to solve your problems.



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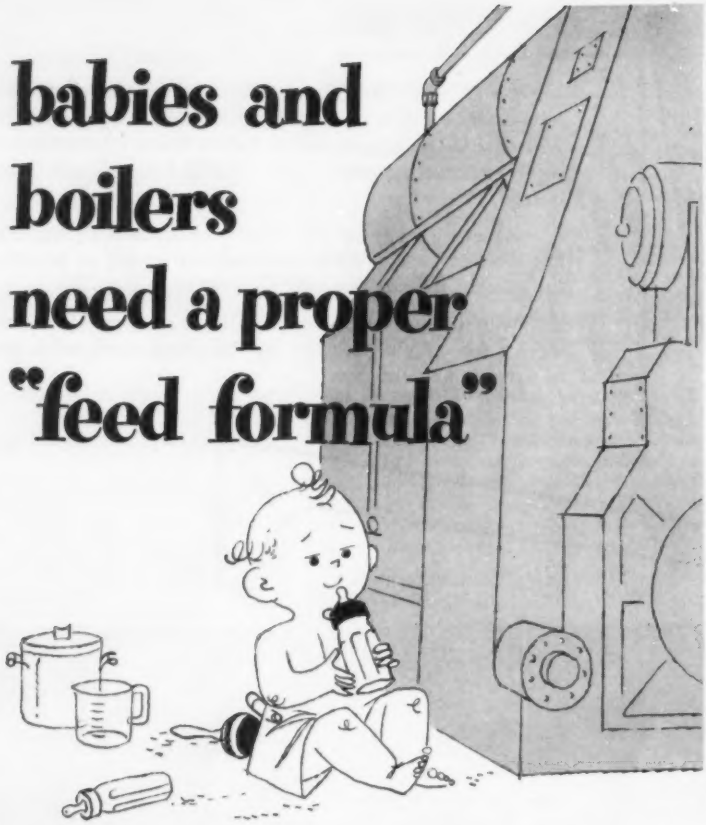
babies and boilers need a proper "feed formula"



ANEXER® and CATEXER® ion exchange plants...

will keep your high pressure boilers and turbines healthy and happy on a low silica, low solids feed water diet.

"CATEXER" and "ANEXER" ion exchangers will deliver the feed water you need even for the highest pressure boilers... with total solids of less than 5 p.p.m., and hardness and silica of less than 0.1 p.p.m. Discover today how INFILCO equipment can safeguard your costly equipment investment... at a chemical cost of a few cents per 1000 gallons.

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Bulletin 1960

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FIELD OFFICES IN 33 PRINCIPAL CITIES IN THE U. S., CANADA AND MEXICO

More POWER NEWS

Begins on page 152

AEC gives plain facts on atomic power

► THOSE WHO LOOK to atomic power as a cure-all for the world's economic ills will find small comfort in the evaluation recently prepared for Congress by the Atomic Energy Commission. The report says flatly that nuclear power will not usher in a new era of plenty—it is merely a promising new energy source that will gradually find its place in competition with existing sources.

The report notes that American conditions are less favorable to the early development of atomic power than are those in certain foreign areas.

Nuclear power plants, the report says, will be available early in the period of 1950-1975 in a range of sizes. Investment costs will run around $75 per kw above cost of conventional steam or internal combustion plants. At 80% capacity factor, these nuclear plants will produce power for 7 to 8 mils per kwhr. Here are some high spots:

(1) Nuclear power plants will be competitive with conventional plants using high-cost coal or oil.

(2) They can't compete with existing hydro or with future hydro at favorable sites.

(3) Even where nuclear power will be slightly cheaper, it won't be a major stimulus to economic growth because power costs are a minor fraction of the operating costs of most industries.

The most likely spots for nuclear power are such nations as Great Britain and Japan, highly industrialized with dwindling low-cost energy sources.

(4) Except in special cases, nuclear power is less likely than conventional power to be economical in the less developed areas.

(5) Some countries may go ahead with uneconomical nuclear-power projects for reasons of national prestige, or to conserve scarce foreign exchange.

S Morgan Smith adding new hydraulic test lab

► A NEW $200,000 hydraulic test laboratory expansion at the S Morgan Smith Co plant in York, Pa, will include what is said to be the world's highest artificial head turbine test stand.

Test heads, representing water backed up behind power dams, will be pumped up to 300 ft at 4500 gpm, or 100 ft at 22,000 gpm. The new stand will test models of Francis and Kaplan turbine runners and include provision for quick change from one unit to another.

The new laboratory addition, to be completed in July, will also include a 16-in. valve demonstration loop for showing operating characteristics of valves sold by the company.

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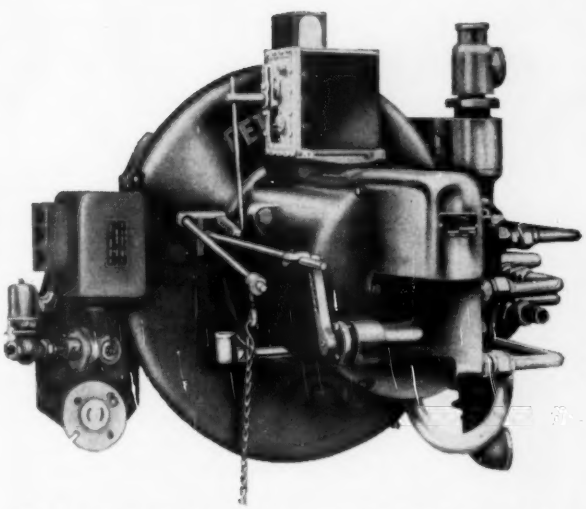
INDUSTRIAL OIL BURNER

Petro follows fluctuating load demands with speed and reliability...

No matter how the steam demand fluctuates, Petro's modulated firing quickly and automatically meets the need. Never underfires or overfires . . . and throttles down to a steady low-burning rate. But savings don't stop here. Petro industrial oil burners also are designed to use low-cost, heavy fuel oils with complete reliability. These heavy oils (Nos. 5 and 6) actually average 8% *richer* in heat value, yet cost less per gallon.

For economy, for performance, for trouble-free service you just can't beat Petro firing. See the Petro section in Sweet's Architectural File, or write for catalog and specifications. Petro, 3020 West 106th Street, Cleveland 11, Ohio. In Canada: 2231 Bloor St. West, Toronto, Ontario.



Rotary type. Burns low-cost heavy fuel oil with complete reliability. Capacities up to 200 gallons per hour. Combination oil-gas models also available, and complete forced draft packaged units.

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Residential Oil and Gas Burners, Oil and Gas Furnaces and Boilers, Industrial and Commercial Oil, Gas and Oil-Gas Combination Burners.

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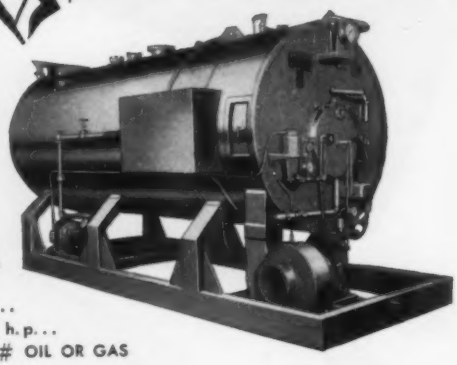
OVER 50 YEARS OF LEADERSHIP IN AUTOMATIC HEATING AND POWER EQUIPMENT

No Annoying "Extras"
IT'S READY TO INSTALL
AND START MAKING
Low-Cost Steam!



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10 to 600 h.p...
15 to 200# OIL OR GAS

AMESTEAM GENERATOR

This automatically controlled packaged boiler unit includes:

★ all piping and wiring, ready for your service connections.

★ fan, feed water pump, condensate tank, injector, blow-off valve, necessary refractories, insulation and metal jacket.

ALL YOU NEED is fuel tank, gas vent and service connections.

—AND YOU KEEP RIGHT ON SAVING with these trouble-free, fully automatic units with their eye-level controls, their accessibility inside and out, and fuel-saving 80% guaranteed efficiency!

FOR FACTS ON LOWER COST STEAM WRITE FOR THIS FREE BULLETIN NOW!

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REPUBLIC
VALVES
INDUSTRIAL • CHEMICAL • AIRCRAFT

***What!* PLUG VALVES THAT TURN EASILY AT 65° BELOW!! WITH NO LUBRICANT!!!**

Up to 250°, down to −65° F, is the range of Republic's LO-TEMP selector valve. Easy turning, positive sealing, at pressures to 100 psi. Tapered TEF-LON plug requires no lubricant, and is not affected by acids or alkalis.

Aluminum body for aircraft and general use, stainless steel for chemical, food, and dairy industries. Angle, 2, 3, 4-way, with or without drain, flanged for panel mounting.

Write for Bulletin No. 754. Distributors in principal cities from coast to coast.

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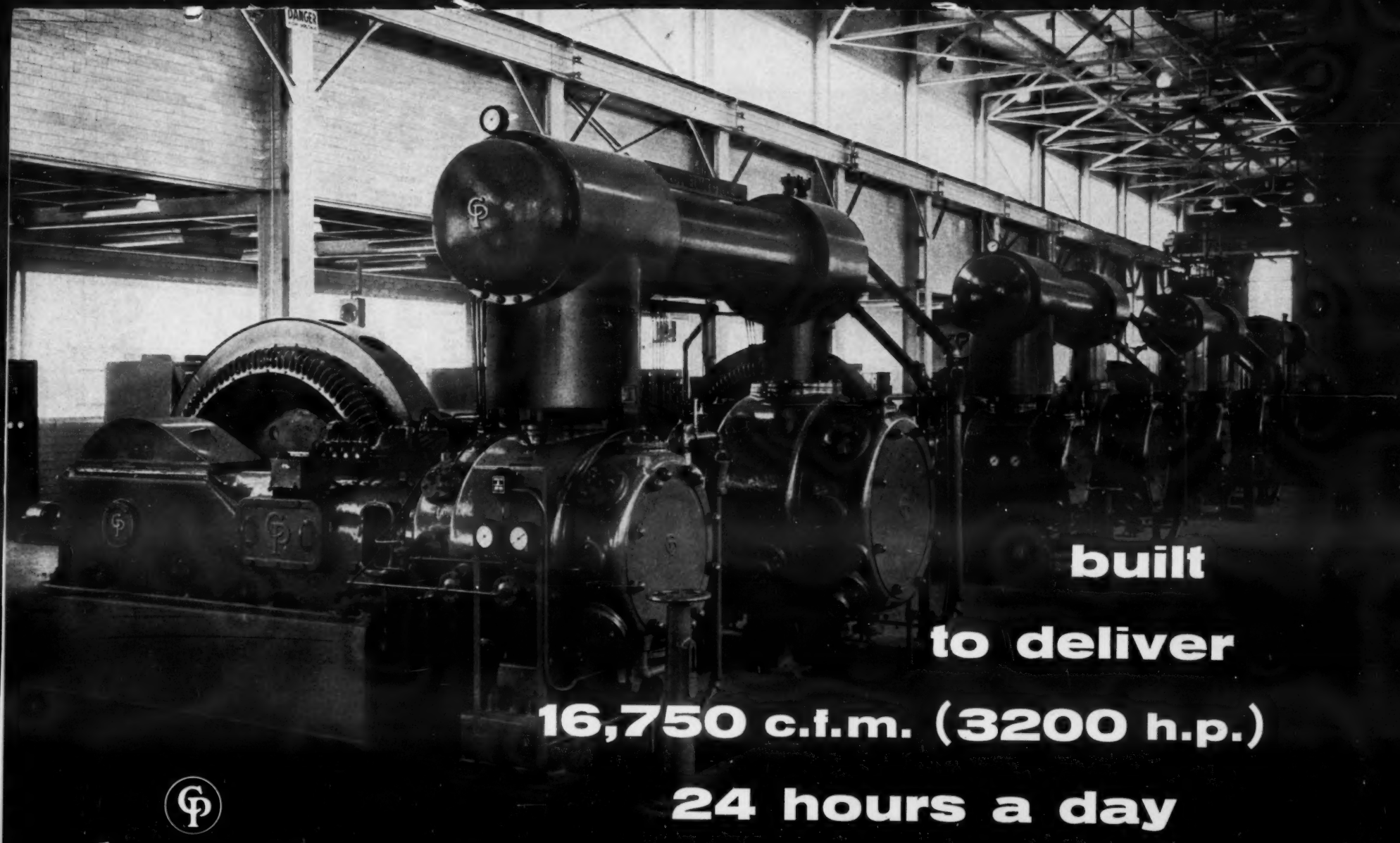

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If you'd like to know how to check weather over your plant . . . day in and day out . . . chances are our experience can help you.

Bendix-Friez offers you all in one package, your own weather station for your own exact location. (The height of your stack, terrain, etc., make a big difference!)

Accurate, meteorological Bendix-Friez instruments tell you the temperature, humidity, windspeed and direction, precisely.

Seventy-seven years of continuous manufacture of precision instruments stands behind your challenge to air pollution.

Offered to you too, is all of Bendix-Friez experience with others that could guide you to the solution of your air pollution problem. Write today.

AEROVANE Indicates and records wind speed and direction. Recognized as "best all-purpose wind measuring instrument yet devised." Readily installed and easily maintained.

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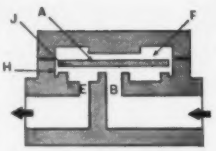
Thermodynamic
TRAP



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Air and/or condensate raise valve seat disc A, discharge thru E. When steam follows, greater velocity causes it to strike body at H thus building up pressure in chamber F. This causes disc to seat, closing tube B. As pressure in F decreases by condensation and leakage thru slot J, pressure in tube B raises disc and cycle is repeated.

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A Good Habit

This Where To Buy Section supplements other advertising in this issue with additional announcements of products and materials of special interest and application in the power generation and transmission field. Make a habit of checking this page each issue.

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FINANCIAL AID TO HIGHER EDUCATION

What Business Can Do to Help Our Colleges and Universities

Is the financial squeeze now gripping our colleges and universities grave enough to warrant direct action by the business community? If so, what can business do about it? This editorial is addressed to these two questions.

In the previous editorial in this series of two, it was demonstrated that **our colleges and universities, and particularly the independent institutions, face financial difficulties, which, unless relieved, promise to get progressively worse and might ultimately result in a national disaster.** This state of affairs obviously gives the business community a crucial stake in helping to relieve the plight of these institutions. For our business organizations can be no stronger than the total community of which they are a part.

It does not follow automatically, however, that every business firm should give direct financial aid to education. Already the business structure is heavily burdened with activities unrelated to its main purpose. These include acting as tax collector for more than $65 billion of federal, state and local taxes in the year 1953. There is a limit to the amount of such public enterprise that can be loaded on the business system.

Business Holds Key to Answer

If, however, the survival of a key part of our educational system depends on its having financial help from the business community, that help should be provided. And this is the situation of our independent privately endowed colleges and universities.

Of course, our tax-supported institutions of higher learning must also be kept strong, financially and otherwise. But they have recourse to public support not available to the independent institutions. Largely on this account, their present financial difficulties are much less acute than those of the independent colleges and universities.

These independent institutions have seen price inflation eat away much of the value of their endowments. Moreover, there is no prospect that these endowments can be sufficiently replenished by gifts from the wealthy people who provided them in earlier years. Progressive income and estate taxes have seen to that. Thus, they are faced not only with a peculiarly acute financial problem, but also one which cannot be solved except by tapping other sources of aid.

Tax Support No Solution

It is conceivable that the independent colleges and universities might solve their financial problem by seeking support from tax revenues. If they did this, however, they would lose their distinctive character as independent institutions, and our system of higher education would lose one of its major elements of strength. That is the existence in our educational system of both independently financed and tax-supported colleges and universities. Each has its special contribution to make to a well-balanced system of higher education.

Business is directly dependent upon higher education to staff its increasingly complex and exacting operations. A key part in this process is played by the small, independent liberal arts colleges which are the hardest hit financially of all our institutions of higher learning. "These," states the Council for Financial Aid to Education, recently formed by a group of business leaders, "have contributed a high proportion of the intellectual, scientific and religious, as well as business leadership of the nation. Their programs are devoted to the teaching of values, particularly the values of freedom. They are a vital bulwark to our system of free enterprise."

Means of Providing Help

There are many means by which business firms can extend help to our colleges and universities. The most obvious, of course, is to make outright grants of money either to individual institutions or to groups of institutions for such uses as the institutions think best. Another means of help, increasingly employed by business firms, is to establish scholarships to pay the full cost of college or university courses of study. Sometimes the scholarships are open for general competition, sometimes they are limited to employees and children of employees of the firm granting them. Not infrequently those winning the scholarships spend some part of their school vacations working in the companies granting the scholarships.

A number of companies have recently provided for what have come to be called "scholarships in reverse." These companies pay a flat sum to a college or university for every one of its graduates they employ. Financing of university research programs also offers a broad avenue for financial aid to our universities by business.

Need Two-Way Communication

Some business firms have well-developed programs for financial aid to education. But they are exceptional. For most companies the problems involved are new and strange. These companies were created with the basic purpose to make money, not to give it away. Successful philanthopic operations involve a whole set of problems with which they have very little experience. Not the least of these is how to make business a dependable source of financial aid to education, since business has no assurance that the profits of one year will not be losses the next.

Considerations such as these emphasize the wisdom of a recent Industry-College Conference on aid to higher education by business, in making the first of its ten conclusions that "better communication, by direct contact, is needed for each [industry and the colleges] to understand the problems of the other." At this juncture the creation of mutual understanding is much more important than the raising of some money and letting it go at that. The problem of aid to education by business has its immediate urgency, but there is also a long-range program to be developed on which business and the colleges and universities must pull together in the years ahead to find a satisfactory solution.

As stated at the outset, failure to find a satisfactory solution could result in a national disaster. This means that, **to give proper heed to their own future prosperity and the future welfare of the nation, business firms generally must go to work on the problem of financial aid to higher education. They must go to work first, to understand the problem; second, to establish two-way communication with our colleges and universities about it; and third, to develop a program which pays proper heed to the needs and capabilities of both business and higher education.**

This message is one of a series prepared by the McGraw-Hill Department of Economics to help increase public knowledge and understanding of important nationwide developments that are of particular concern to the business and professional community served by our industrial and technical publications.

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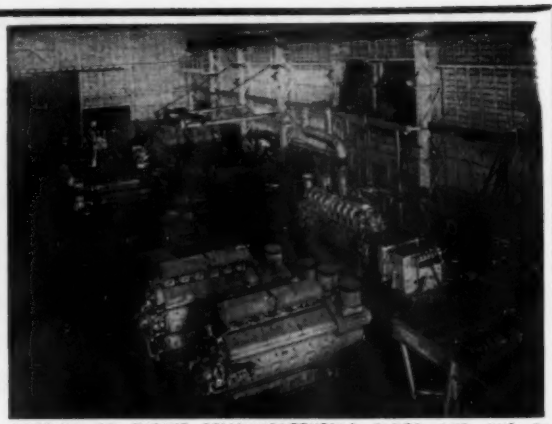

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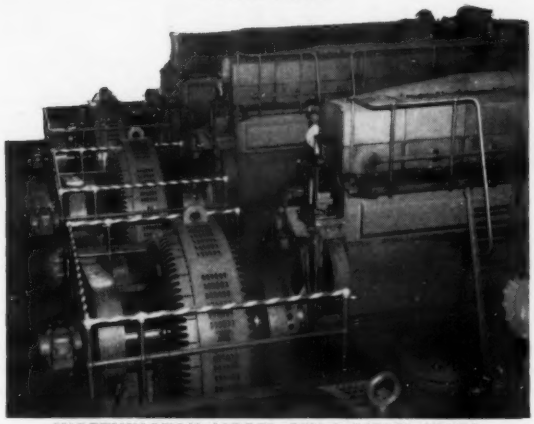

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150	G.E.	IM	1200	slip ring, S.B.
150	G.E.	KT 584	600	B.B.
125	L.A.	FX 5055, new	1800	B.B. splash proof
100	L.A.	JA 5055, new	1800	TEFCBB
100	L.A.	FX 5045, new	1800	B.B. splash proof
100	Cr. Wh.	SC	1200	TEFCBB
100	G.E.	KT 347	1200	S.B.
100	West.	CS 607	1200	S.S.B.
100	G.E.	MT 356	900	slip ring, S.B.
100	F.M.	H-205C	900	B.B.
100	G.E.	IM	720	S.B. slip ring
100	West.	CW	600	slip ring, S.B.
75	West.	CS 504	1800	TEFCBB
75	West.	CS 445	1800	B.B.
75	G.E.	MT 343	1200	slip ring, B.B.
60	Ideal	AH 443, new	1800	S.B.
50	Ideal	A 405, new	1800	S.B.
40	L.A.	DGX 403, new	1800	drip proof, S.B.

This is a partial listing. CALL or WIRE COLLECT on your motor requirements.

POWER EQUIPMENT COMPANY

8 CAIRN ST., ROCHESTER 2, N. Y. P. O. BOX 534 Tel. Genesee 5629

THANKS FOR THE APPLAUSE!

SATISFIED CUSTOMERS REPEAT ORDERS
HAVE BUILT THE VOLUME BUSINESS
WE DO SELLING

HEMPHILL *Guaranteed* EQUIPMENT

DIESEL GENERATOR SETS

3—75K2A C.W., 120/208 V., 3 Ph., 1200 RPM. V Belt. to KRUPP, 3C1/L., 2 cy. solid injection complete.

TRANSFORMERS—60 Cycle

Qu.	KVA	Make	Type	Ph	Voltages
1	1000	G. E.	Auto	3	4150x2400
2	750	G. E.	HT	3	4150x120/240
2	750	G. E.	H	1	4600-120/240
1	500	Kuhl.	OISC	1	4150x2400
2	400	Pitts	OISC	1	4800/4150/2400 x240/480
3	333	Whse.	OISC	1	2400x575
1	333	G. E.	H	1	13200x220/440
2	300	G. E.	H	1	13200x440
4	300	G. E.	H	1	13200x440
1	300	G. E.	HT	3	2400x240
2	150	Pitts.	ODSC	1	240x120/240
3	50	G. E.	H	1	4800x120/240
3	50	A. C.	H	1	230x120/240
1	25	G. E.	H	1	460x120/240

SLIP RING MOTORS

Qu.	H.P.	Make	Speed	Type	Volts
1	500	G. E.	1200	M	2400/4150
1	400	Whse.	450	CW	550
1	250	Whse.	600	CW	440
2	200	Whse.	600	CW	440
1	200	G. E.	600	MT	440
1	150	A. C.	1800	AY RW	2300
1	100	G. E.	1800	IM	220
1	100	G. E.	600	IM	440
1	75	G. E.	600	IM	440
3	60	G. E.	1800	MT	220

DC, 230 VOLT MOTORS

Qu.	H.P.	Make	Speed	Type
1	300	G. E.	1200	MPC
2	150	C. W.	900	WP
1	125	G. E.	1700	RC
2	75	C. W.	900	WP
1	30	C. W.	700	CM
1	35	G. E.	860	RC
1	25	Whse.	835	SK

WESTINGHOUSE M.G. SET

1000 KW, 600V D.C., 2400/4160V, 720 RPM, 3 Ph., 60 Cy., 7 PF Syn. Motor. Direct Connected Exciter, Motor Driven Rheostats, Switch Boards, all for full automatic operation.

SQUIRREL CAGE MOTORS

Qu.	Make	Speed	Type	Volts
150	G. E.	720	KT	440
125	G. E.	3560	KF	2300
100	G. E.	1200	FTR	220
75	Ideal	1200	AT	220/440
60	G. E.	1200	KT	220
50	G. E.	3560	FT	220
50	G. E.	600	KT	440
40	G. E.	3550	FT	440
30	G. E.	600	KT	440

MOTOR GENERATOR SETS

Qu.	KW	Make	Speed	DC	AC
1	1000	G. E.	514	600	2300/4150 Syn
1	1000	Whse.	720	600	2300/4150 Syn
1	1000	Whse.	720	275	2300/4150 Syn
1	300	C. W.	1200	230	3-unit 2400/4150SR
1	300	G. E.	1200	230	2400/4150SR
1	200	Whse.	900	250	2300/4150 Syn
1	150	C. W.	1200	230	440 SC
1	150	3 Unit G. E.	1200	125/250	2300 Syn.
1	150	Whse.	600	125	4150 Syn.
1	125	C. W.	1200	125	2300 S.C.
1	100	G. E.	900	250	2300 Syn.
3	60	G. E.	1200	125	208 Syn.
2	30	G. E.	1200	125	440 SC

SYNCHRONOUS MOTORS

Qu.	H.P.	Make	Speed	Type	Volts
1	300	El. Mach.	720	TEFC	2200
3	200	Whse.	720		4150
1	175	G. E.	720	ATI	2300
1	150	G. E.	720	ATI	2300
1	150	G. E.	1800	T8	220
1	150	Whse.	900	ISIG	220

OIL CIRCUIT BREAKERS

3—600 AMP. G. E. FKR-55-20, 15,000 V. 3 P. 100,000 KVA, SOLENOID OPER.

1—600 AMP. G. E. FK-143, 15,000 V. 3 P. 50,000 KVA, Manual with Disconnects, Metal Clad Enclosure.

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JLHCo

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"FOR POWER"
J.L. HEMPHILL & CO.
1603 54th STREET, NORTH BERGEN, N. J.
PHONE NEW YORK LONGACRE
PHONE NEW JERSEY UNION

BOILERS

1—350 HP Hedges-Walsh Weidner 225 psig

CIRCUIT BREAKERS

1—1200 amp G.E. FKHO-236, 15 KV, 3 pole
1— 400 amp West. GI, 73 KV, 3 pole

DIESEL GENERATORS

1—300 KVA Superior YLO—G.E. Gen. 400 RPM 2200/440/3/60

MOTORS—SQUIRREL CAGE

1—150 HP 1800 RPM 440/3/60 West. CS-771
1—150 HP 3600 RPM 2200/3/60 West. CS-6756H

MOTORS—SLIP RING

1—400 HP 250 RPM 440/3/25 G.E. I-12 S.B.
1—360 HP 350 RPM 2300/3/60 G.E. IM S.B.
1—200 HP 1800 RPM 440/3/60 G.E. LE13B S.B.
1—200 HP 1800 RPM 2200/3/60 G.E. I S.B.
1—150 HP 600 RPM 2200/3/60 G.E. I-M S.B.
1—150 HP 720 RPM 440/3/60 G.E. OI S.B.
1—125 HP 600 RPM 440/3/60 G.E. I-12 S.B.
1—100 HP 600 RPM 2200/3/60 G.E. I-12 S.B.

MOTORS—SQUIRREL CAGE—EXPLOSION PROOF

2—75 HP 1800 RPM 2200/3/60 G.E. K-505S

TRANSFORMERS—1 PHASE 60 CYCLE

3—3333 KVA 66000 to 33000 & 13200 v.
2—1000 KVA 13200-2300 v.
3— 500 KVA 38100/66000 Y—2300 v.
3— 500 KVA 33000 v—2300 v.
4— 500 KVA 13200 v.—2300 v.
4— 200 KVA 33000 v.—2300/4160 Y
5— 200 KVA 13200—2300/4160 Y
1— 200 KVA 12000—2300/4160 Y
3— 200 KVA 7620/13200 Y—2300
1— 150 KVA 66000—2300/4160 Y

TRANSFORMERS—1 PHASE 60 CYCLE

14—100 KVA 33000-23000/4160 Y
9—100 KVA 13200-2300/4160 Y
6—100 KVA 7620/13200-2300/4160Y

TURBO GENERATORS

1000 KW West. Cond. 185 lbs. 100° SH 3/60/2300
1500 KW G.E. Non-Cond. 140 lbs. 3/60/2300
1000 KW G.E. Non-Cond. 140 lbs. 3/60/2200

PUMPS—BOILER FEED

600 GPM 1220' hd. DeLaval 3550 RPM Requires 250 HP
600 GPM 1220' hd. Conn. 233 HP 3550 RPM 400 lb. pres. DeLaval turbine
400 GPM 1250' hd. Worthington 1750 RPM 5" x 4"

CENTRIFUGAL PUMPS

5200 GPM 55' hd. Worthington 18 x 14, 1150 RPM 100 HP reqd.
5000 GPM 214' hd. Pennsylvania 15½ x 14, 1775 RPM 300 HP required.
4375 GPM 100' hd. DeLaval 14 x 12, 1270 RPM
3500 GPM 37' hd. DeLaval 12 x 12, 1160 RPM 60 HP req'd.
3200 GPM 50' hd. Gardner Denver 10 x 12, 1160 RPM 60 HP required.
3500 GPM 160' hd. DeLaval 10 x 10, 1750 RPM, 200 HP req'd.

MOTOR GENERATORS

1000 KW 600 volts DC 514 RPM West. 2300/3/60
48 KW 30 volts DC 600 RPM Stanley Elect MG 75 HP 220/3/60
16.8 KW 42 volts 1800 RPM Hertner 220/2/60

AIR COMPRESSORS

570 CFM 17 x 12, 55 psi, single stage Ingersoll-Rand Type ER1, 75 HP.
335 CFM 14 x 10, 100 psi, single stage Ingersoll-Rand Type ER1, 100 HP.
310 CFM 8 x 12 x 8 50 psi, single stage, steam driven Ingersoll Rand Type FR1.

GENERATORS—GAS ENGINE

99¾ KVA, 230/3/60 Star Buda with charger
66½ KVA 240/3/60, 4 wire Waukesha-Bardco Type C12 truck mounted

SYNCHRONOUS MOTORS

400 HP 1800 RPM 2200 volts Westinghouse .8 PF
300 HP 400 RPM 2200/440/3/60 General Electric Type T8
290 HP 720 RPM 2200/3/60 General Electric Type AT1 pedestal bearings
150 HP 1800 RPM 2200/3/60 General Electric Type ATI with dir. con. exc.

GENERATORS—STEAM ENGINE DRIVEN

65 KVA 327 RPM 220/3/60 Engberg 9 x 10 vertical engine.
160 IHP 260 RPM Skinner steam engine 15 x 15, 100 lbs. 5 lbs. back

MOTORS—GEARHEAD 3 PHASE 60 CYCLE

40 HP 494 RPM General Electric Type K-444 Vertical parallel shaft
3 HP 220 RPM Kelley Compactor TE vertical
½ HP 0.508 RPM Universal, Type K-18282 parallel shaft

MOTORS—VERTICAL 3/60AC

75 HP 1750 RPM U.S. Type CFU-950 hollow shaft
50 HP 1800 RPM G.E. Type KT-531Y hollow shaft
40 HP 1800 RPM G.E. Type KT-323 Solid shaft
30 HP 1200 RPM U.S. Type SCV-937 Solid shaft

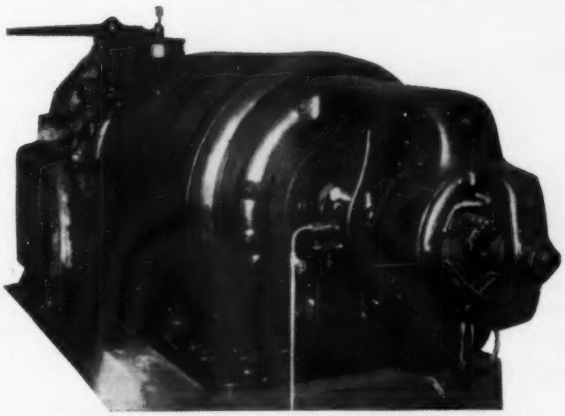
TAMPA ARMATURE WORKS INC.

401 S. MORGAN ST. TAMPA, FLORIDA PHONE 2-1966

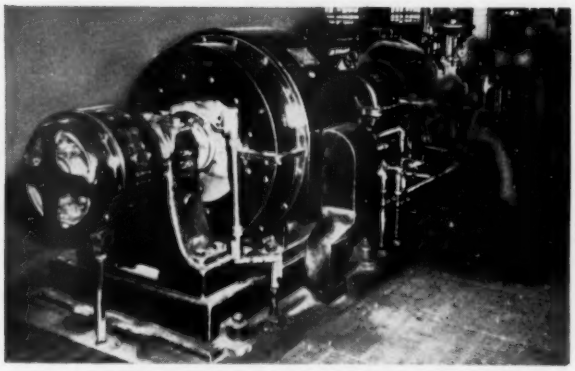
BARGAIN OFFERINGS

Turbo Generators—Unaflow Engine Generators—Diesel Generators

All Equipment Priced to Sell



1250 KVA G.E. 2300/440 volts NON-CONDENSING 150# PSI, 10# gauge back pressure.



500 KVA TERRY, 480 volts NON-CONDENSING 325# PSI, 110# gauge back pressure.

TURBINE GENERATOR UNITS

Condensing—3 phase, 60 cycle

33000 KVA G.E., 12,000 volts, 235# PSI.

6250 KVA G.E., 5-stage, 2300/4160 volts, 200# PSI, 600°TT.

6250 KVA G.E., 2400 volts, 400# PSI.

3750 KVA Westg. 4150 volts, 350# PSI.

3125 KVA Westg. 4160 volts, 185# PSI automatic extraction.

2500 KVA Allis 2300 volts, 350# PSI.

2500 KVA G.E. 2300/480 volts, 3600 RPM generator **LESS TURBINE.**

2500 KVA G.E. 600/480 volts, 275# PSI, automatic extraction.

1563 KVA G.E. 480 volts, 150# PSI, automatic extraction.

1250 KVA G.E., 2300 volts, 125# PSI.

1250 KVA Allis, 480 volts, 250# PSI, automatic extraction.

940 KVA Elliott 2300 volts, 3600 RPM generator **LESS TURBINE.**

937 KVA Allis, 2300 volts, 250# PSI.

937 KVA Terry, 240/480 volts, 200# PSI, automatic extraction.

Non-condensing—3 phase, 60 cycle

5000 KVA G.E. 13,800 volts, 600# PSI.

1563 KVA G.E. 480 volts 200# PSI, 20# bk.

1250 KVA (2) G.E. 2300/480 VOLTS, 150# PSI 10# BACK. (Photograph Above)

1000 KVA Westg. 480 volts, 110# PSI, 15# bk.

937 KVA ALLIS, 480 VOLTS, 150# PSI, 10# bk.

937 KVA (2) G.E. 480 volts, 150# PSI, 15# bk.

625 KVA Westg. 2400 volts 250# PSI, 50# bk.

625 KVA G.E. 2300/480 volts, 150# PSI, 50# back.

500 KVA TERRY, 480 VOLTS, 325# PSI, 110# BACK. (Photograph above)

125 KVA Westg. 2400/480 volts, 125-250# PSI, 5# back. Geared unit.

SPECIALLY PRICED

1500 KW (2) Westg. 60 cycle 6 phase, synchronous rotary converters 600 volts DC, 514 RPM, complete automatic substation. EXCELLENT CONDITION.

UNAFLOW GENERATOR UNITS

3 phase, 60 cycle

625 KVA Skinner 240 volts, 150# PSI.

525 KVA Nordberg 2300 volts, 150-200 PSI.

375 KVA Skinner 480 volts, 150# PSI.

375 KVA (2) Skinner 600 volts, 150# PSI.

250 KVA Skinner 2300 volts, 150# PSI.

DIESEL GENERATOR UNITS

3 phase, 60 cycle

592 KVA F.M. Model 33E14, 2400 volts, 300 RPM, NEW 1948.

429 KVA F.M. Model 33F12, 2400 volts, 400 RPM NEW 1948.

250 KVA Buckeye 2400 volts, 450 RPM.

111 KVA (2) F.M. 2400 volts 300 RPM.

DIRECT CURRENT UNITS

400 KW G.E. 3-wire 250 volt DC, 360 RPM generator connected Skinner Vertical Unaflow engine 150# PSI, 5# back.

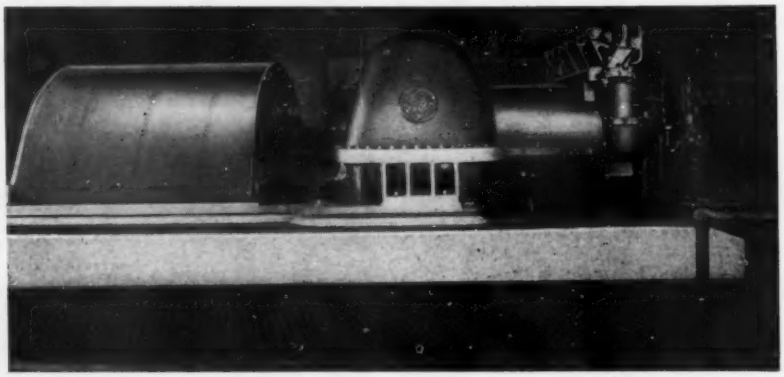
300 KW Westg. 3-wire DC 250 volts 150/250# PSI non-condensing turbine.

60 KW Elliott 125 volts DC non-cond. turbine generator 200-250# PSI (exciter sets modern).

UMC UTILITIES MACHINERY CORP.

1965 EAST 6th STREET • CLEVELAND 14, OHIO • CH. 1-0210

3750 - G. E., 400#, 750 F.T.T. TURBINE-GENERATOR



Above view was made from a recently taken photograph of the 3750-KVA, G.E., Turbine. It is a condensing machine complete with 2-pass, 6000 sq. ft. Surface condenser, Switchboard with instruments, D.C. Exciter. Voltage is 3/60/2300-4160-V.

MACHINE CAN BE INSPECTED IN OPERATION

We own and offer any Capacity Turbine from 300-KW to 12,500-KW. Complete line of Boilers, also Diesel Engines. Send us your specs.

TELEPHONE WIRE OR WRITE.

CHARLES WEAVER
4145 PENOBSCOT BUILDING
DETROIT 26, MICHIGAN

TELEPHONE: WO. 1-1340

MOTORS - GENERATORS M-G SETS

Electrical Equipment of All Kinds

Rebuilt and Guaranteed LOWEST PRICES

LOW VOLTAGE MOTOR GENERATOR SETS

1—Hobart, 1000/500 amps, 6/12 volts
1—Chandy, 5000/2500 amps, 6/12 volts
1—Ridgeway, 4500 amps, 30 volts
1—Chandy, 3000/1500 amps, 24/48 volts
1—G.E., 600 amps, 30 volts

GEAR HEAD MOTORS

5—Link Belt, 20 HP, 74 RPM, TE
4—G.E., 40 HP, 561 RPM, TE
5—G.E., 60 HP, 427 RPM, TE

VERTICAL SETS

1—450 HP, G.E., 2300/3/60-1200 RPM, Type KF

AC & DC MOTORS—PUMPS AIR COMPRESSORS

LARGEST STOCK IN MIDWEST

BUCKEYE
Trading Corporation

1017 PAPIN ST. LOUIS 2, MO.
CHESTNUT 1-3110

COMPLETE POWER PLANT

4—1285 HP B. & W. Boilers, rated 225# psig steam, A.M.S.E. code, lower tubes retubed in 1952, C/W underfed stokers, boiler feed pumps, blowers, Cochrane Heater, pipes & valves, etc.

1—15,000 KVA G. E. Turbo-Gen. Set, type ATB-4, 3 ph., 60 cy., V 9000, 1800 RPM, direct connected to a Curtis Condensing Turbine, 200# psig steam, C/W 20,000 sq. ft. C & H Wheeler Surface Condenser, Condensate Pump, Switchboard, etc.

1—50 ton Whiting Power House Overhead Crane with 10 ton aux. hoist, 45' span, 3/440/60, operator cab.

Location—New York State. Price and further information on request.

PHILA. TRANSFORMER CO.
2829 Cedar St. Phila., Pa.

FLUID DRIVE - GYROL TYPE VS
HYDRAULIC COUPLINGS

Stepless speed variation with constant speed prime mover made by American Blower Co. Ideal for pumping stations, steel mill drives, mechanical draft fans, crushers, rotary kilns, etc.
Wide range of capacities—Condition 98% new
200 HP to 2500 HP Input
300 RPM to 900 RPM Input
Complete data & quotations on request.
Also large selection of marine couplings, reduction gears, & Falk grid type couplings in stock.

A.G. SCHOONMAKER CO., INC.
50 Church St. New York 7, N. Y.

FOR SALE
18 NEW TURBINES

4 horizontal, 14 vertical, Westinghouse

Driving forced draft blowers—capacities ranging from 39000 to 56000 CFM and 16" to 24" pressure. Steam pressures 360 to 575#, back pressure 10#.

Will sell turbines separately if desired. *Price reasonable.*

Also—1—250 KW GE turbo generator unit, 3 phase, 60 cycle, 440 volt. Used one year.

G. M. DeROSE
2457 WOODWARD AVE.
408 DONOVAN BLDG.
DETROIT 1, MICH.

FOR SALE BOILER

1—150 HP Leffel Scotch Marine 125#
2—Peerless feed water pumps; one with electric motor; one steam turbine—6 stage

NATIONAL BOILER & EQUIP. CO.
1501 S. Senate Ave., Indianapolis 25, Ind.

BRONZE VALVES FOR SALE

36" bronze Chapman valves—30 pound pressure.

THE BOSTON METALS CO.
313 E. Baltimore Street
Baltimore 2, Md.
Curtis 7-5050

500 HP 600 lb. P. WT Boiler—1946
450 HP 160 lb. P., Package—1951
80 HP 125 lb. P., Erie City Boiler
300 KW Skinner Unaflow Eng. Gen. Set
7500 KW GE-Curtis Turbo Gen. Set
150 HP, 1200 RPM Slip Rg. Motor
6x6" High Speed Air Compressor
8' Raymond Whizzer Air Separator

H. & P., 6719 Etzel, St. Louis 14, Mo.

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NOW IS THE TIME TO BUY....

"Certified Rebuilt" Motors and Generators

HIGHEST QUALITY . . . REDUCED PRICES

Check with WAGNER First

A. C. GENERATORS — 60 CYCLE

KVA	Mfr.	Type	Volts	Speed
1000	Whse. syn cond		4060/2300	900
625	Gen. Elec.	ATB	2300	450
600	Gen. Elec.	ATB	480	900
625	El. Machy.	Late	240/480	1200
485	Allis Ch.	1 brg.	480	400
350	El. Machy.	1 phase	480	1200
312	Gen. Elec.	ATB	240/480	600
275	G. E. 25 cycle	ATI	480	750
225	El. Machy.		480	720
225	Gen. Elec.	ATI	240/480	900
150	Allis Ch		240/480	1200
150	Gen. Elec.	ATB	2300	900
150	Whse.		2300/480	600
125	El. Machy.	Syn.	240/480	1800
125	Gen. Elec. (2)	ATB	240/480	900
112	Gen. Elec.	ATB	240/480	900
75	El. Machy.		2300	900
56	G. E.	ATB	240/480	1200
25	Whse. b.b.	1 phase	120/240	900
10	Kato b.b. New	3 phase	127/220	1800

LOW VOLTAGE M-G SET
Whse. 3636 amp. 20/55 V DC gen. w/synch. motor 220/440 V. 720 RPM and exciters.

D. C. GENERATORS

KW	Mfr.	Type	Volts	Speed
300	Al. Ch.	MECW	125/250	1200
250	Allis. Ch. b.b.	EW	350	1200
250	Gen. Elec.	MPC	250	600
200	Gen Elec.	RC	250	1150
150	Gen. Elec. b b.	CDM	250	1500
105	Century b.b.	1500 amp.	70	1200
100	Allis Ch.	E	125	1200
100	Allis Ch.	E382	250	900
100	Delco b.b.	Mar.	125/250	1200
75	Cont. b.b.	D109X	125	1150
75	G. E. b.b.	CD	250	1050
75	F. M. b.b.	DH	125	1800
75	G. E. b.b. (2)	CDM135	125	750
75	Whse.	SK	250	900
75	Columbia b.b.		120/240	1450
60	Allis Ch.	E147	250	900
60	Whse. b.b. (2)	SK121	300	1200
50	Cr. Wh. b.b.	CCD	250	1800
50	Reliance	T	250	1150
40	Gen. Elec.	CD103	250	1500
40	F. Morse b.b.	DH	125	1800
40	Gen. Elec.	RC	600	1750
25	Whse.	SK93	125	1750
25	C. W. b.b. (2)	CCD	250	1200
20	Gen. Elec.	RC	125	1150

A. C. MOTORS — 60 CYCLE

HP	Mfr.	Type	Volts	Speed
750	Whse.	Synch.	2200/4000	900
700	G. E.	Synch.	2200	514
600	E. M.	Synch.	480	1200
550	G. E.	Sq. Cage	2200	3600
500	G. E.	Slipring	2200/440	450
500	G. E.	Synch.	440	900
450	Allis Ch.	Synch.	480	400
400	Whse.	Sq. Cage	2200	514
400	G. E.	Synch.	440	450
400	Allis Ch.	Sq. Cage	2200/440	1200
350	G.E. Ex. Pr.	Sq. Cage	2200/440	3600
350	Whse.	Slipring	2200/440	600
350	Whse. (2)	Slipring	2300	450
300	El. Machy	Synch.	220/440	360
300	Al. Ch.	Sq. Cage	2200/440	720
300	Whse.	Synch.	2200/440	600
300	Al. Ch.	Slipring	2300	514
300	G. E.	Slipring	440	360
250	G. E.	Synch.	220/440	720
250	Whse. (2)	Sq. Cage	2200/440	1200
250	L. A. (2)	Sq. Cage	2200	1800
225	G. E.	Synch.	220/440	900
200	Allis Ch.	Slipring	440	450
200	Gen. Elec.	Sq. Cage	2200/440	720
200	Cr. Wh.	Sq. Cage	220/440	3600
200	Whse.	Sq. Cage	2200/440	900
200	G. E.	Slipring	220/440	600
200	E. M.	Synch.	220/440	1200
200	G. E.	Slipring	220/440	360
200	Whse.	Sq. Cage	220/440	1800
200	E. M.	Synch.	220/440	514
200	Wagner	TEFC	2200	1200
175	G. E. (2)	Synch.	220/440	720
175	Whse.	Synch.	220/440	360
150	Whse.	Sq. Cage	220/440	900
150	G. E. TEFC	Sq. Cage	2200	3600
150	Allis Ch.	Slipring	2200/440	720
150	G. E.	Synch.	220/440	450
150	Allis Ch.	Slipring	2200/440	720
150	G. E. (2)	Sq. Cage	2200/440	720
150	G. E.	Slipring	220/440	450
150	Allis Ch.	Sq. Cage	2200/440	1200
150	Rel. b.b.	Sq. Cage	220/440	1800
150	Allis Ch.	Sq. Cage	440	450
125	Rel. TEFC	Sq. Cage	220/440	1800
125	G. E. (2)	Slipring	220/440	600
125	G. E.	Slipring	220/440	450
125	E. M. (2)	Synch.	220/440	1800
125	Allis Ch.	Slipring	220/440	900
100	Burke b.b.	Synch	220/440	1800
100	Whse. b.b.	Sq. Cage	220/440	900
100	G. E. New	Slipring	220/440	1200
100	G. E. TEFC	Sq. Cag	220/440	1200
100	G. E.	Slipring	220/440	900

48 Years of Service to American Industry

D. C. MOTORS

HP	Mfr.	Type	Volts	Speed
300	Allis Ch. b.b.	EW	350	1000
250	Gen. Elec.	LDR	250	450/850
200	G. E. (2)	RC59	230	850
150	Whse.	SK-201	230	300/900
100	G. E. dyna.	TLC-50	250	1050/4000
100	Allis Ch.	E182	230	600/1200
75	F. Morse b.b.	DH140	115	1600
75	Whse.	SK170	230	635
50	Whse.	SK173	230	300/1200
50	Reliance	310T	230	850
50	Reliance b.b.	651T	230	750
50	Cr. Wh. b.b.	FH	230	1750
50	Whse.	SK185	230	300/900
40	Whse.	SK143	230	600/1500
40	Reliance	651T	230	350/1000
40	Allis Ch.	E-121	230	1750
40	Gen. Elec. (2)	CD103	250	1150
40	Gen. Elec.	RC32	550	1200
40	F. Morse b.b.	DH 120	115	1750
30	Imperial b.b.	D69	230	400/1600
30	Star b.b. (3)	SB	230	1750
25	Star b.b.	SB	230	1750
25	L. A. TEFC	RNA	230	850
25	Whse.	SK150	230	300/1200
25	Gen. Elec.	CD105	230	575/1720
25	Whse.	SK-100L	230	1150
20	Century b.b.	DN326	230	3500
20	G. E. series	CO-1826	230	875

MOTOR-GENERATOR SETS

KW	Mfr.	Input V	Output V
500	Whse.*	2300 AC	250 DC
300	G. E.*	440 AC	250 DC
300	Allis Ch.	2200/440 AC	125/250 DC
300	Whse.*	2300 AC	600 DC
250	Allis Ch.	2200/440 AC	350 DC
200	Whse.* (2)	220/440 AC	55 DC
200	G. E.*	220/440 AC	250 DC
200	Gen. Elec*	220/440 AC	125 DC
150	Whse.	2200/440 AC	275 DC
105	Century b.b.	220/440 AC	70 DC
100	Al. Ch.	220/440 AC	125 DC
100	Delco b.b.	220/440 AC	125/250 DC
80	Star* b.b.	220/440 AC	240 DC
60	Gen. Elec.*	220/440 AC	60 DC
60	Whse. (2)	220/440 AC	300 DC
50	Gen. Elec.	220/440 AC	125 DC
50	Allis Ch.	220/440 AC	125/250 DC
50	Cr. Wh. b.b. (4)	220/440 AC	240 DC
40	G. E. (2)	220/440 AC	250 DC
40	Gen. Elec.	220/440 AC	600 DC
25	Whse.	220/440 AC	125 DC
25	Gen. Elec.	220/440 AC	250 DC
20	Star b.b.	220/440 AC	120 DC
16	Gen. Elec.	220/440 AC	125 DC
15	El. Prod.	220/440 AC	40 DC

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TELEPHONE MONROE 6-7409

SLIP RING MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Speed
600	440	Whse.	1800
600	2200	Whse.	450
500	2200/4000	G. E.	900
450	440	Whse.	514
450	440	Whse.	720
400	440	G. E.	900
300	4000/2300	Whse. (new)	600
300	2200/440	G. E.	720
300	440	G. E. (hoist)	600
300	2200	G. E.	360
300	440	Whse.	3600
250	440/220	Whse.	600
250	550/440	G. E.	1200
250	440	G. E.	600
200	440/220	Whse.	514
200	440	G. E.	450
150 (2)	440/220	G. E.	720
150	2200/440	G. E.	600
150	550/220	G. E.	720
145	4000/2300	G. E.	1800
135	440/220	G. E. (hoist)	600
125	440/220	G. E.	900
125	550/440	G. E.	1200
125	2200	G. E.	600

SYNCHRONOUS MOTORS 3-Ph., 60 Cy.

H.P.	Volts	Make	Type	R.P.M.
400	2200/440	G. E.	ATI	720
375	440/220	Whse.	G	900
350	440/220	El. Machy.	Syn.	1200
300	2300/400	G. E.	TS	720
300	2200/440	G. E.	TS	1200
250	2200/440	G. E.	TS	720
250	440/220	G. E.	ATI	1200
250	2300	G. E.	TS	3600
250	440/220	Whse.	HR	277
250	2200/440	G. E.	TS	1200
250	440/220	G. E.	ATI	600
200	4150/2300	Whse.	G	1800
125	440/220	Whse.	HR	400
110	440/220	G. E.	TS	257

SQUIRREL CAGE MOTORS

H.P.	Volts	Make	Type	Speed
600	2200	G. E.	FT	3600
500	2200	Whse.	CS	514
500	2200/4000	Elliot	SC	1800
500	2200	G. E.		450
400	2200	G. E.		360
400	2200/400	Whse.	CS	720
300	2200	L. Allis	FS	1800
250	2200/440	G. E.	IK	720
225 (2)	2200/440	G. E.	KT	1200
200	2200/440	G. E.	K	1200
200	440	G. E.	IK	720
200	440/220	G. E.	KT	1800
200	2200/440	G. E.	JK	600
200	2200	G. E.	KT	1800
150	440/220	Whse.	CS	900
150	2200	Al. Chal.	AR	1800
150	220	Whse.	CS	1200
150	440	Multi sp.	KT	1800/600
150	440/220	G. E.	IK	450
150	440/220	G. E.	KT	720
150	440/2200	G. E.	IK	514
150	2200/440	G. E.	KT	600
125	440/220	G. E.	KT (vert.)	1200
100	2200/440	G. E.	K	1200
100	220/440	G. E.	K-TEFC	720
60 (2)	2200	Whse.	CS X-pf.	1800
50 (2)	440/220	Whse.	CS-TEFC	1800
50	220	Al. Chal.	X-prf.	600/1200

A. C. GENERATORS

1—320 kva, 660 rpm 2300/440/220 V., G.E.
1—300 kva, 900 rpm, 480/220 V., G. E.
1—250 kva, 720 rpm, 2300/440 V., G. E.
1—225 kva, 600 rpm, 220/440 V., G. E.
1—200 kva, 720 rpm, 2200/440 V., G. E. (Ball brg.)
1—187 kva, 1200 rpm, 2200/440 V., Whse.

CIRCUIT BREAKERS

2—2000 amp. GG E., 3 pole, 600 V.
2—1600 amp. ITE, 3 pole, 600 V.
6—FKR-155-28, 600 amp., 15,000 V., G. E., Sol. ope., draw-out.

D. C. MOTORS

H.P.	Volts	Make	Type	Speed
250	230 (2 new)	Cr. Wh.	CMC	1800
225	230	Whse.	SK	2870
200	230	G. E.	CD	750
150	230	Whse.	SK	1750
100	230	Whse.	SK	400/1200
100	230	Cr. Wh.	CMC	625
90	230	G. E.	CD	1750
80	230	G. E.	RC	600
50	230	Rel.	T	400/1200

MOTOR GENERATOR SETS

KW	Make	Input V., AC	Motor Type	Output V., DC
250	Whse.	440/220	Syn.	250
250	Whse.	2200	Syn.	250
175	G. E.	220/440	Syn.	230
125	G. E.	440/220	Syn.	250/125
100	Al. Ch.	220/440	sq. ca.	240/120
100	Whse.	440/220	sq. ca.	125
75	G. E.	2200/440	Syn.	125
65	G. E.	2200/440	sq. ca.	250
65	G. E.	2200/440	sq. ca.	125
45	G. E.	440/220	sq. ca.	250

TRANSFORMERS 60 Cy.

3—667 kva, Al. Chal., 22000/11000/2300 V.
1—600 kva, Standard, 13,800-2300 V., 3 ph.
3—500 kva, G. E., 22000/11000—2300 V.
3—500 kva, Whse., 66000—2300 V.
3—333 kva, G. E., 12000—2300 V.
3—200 kva, G. E., 2300—575 V.
3—200 kva, G. E., 11000—2300 V.
3—200 kva, G. E., 4150—480/240 V.
3—150 kva, G. E., 33000—2300/4600 V.
3—150 kva, Al. Chal., 2400—240/480 V.
3—150 kva, Al. Chal., 2400—240/120 V.
6—100 kva, Whse., 2400—120/240 V.
6—100 kva, G. E., 4150—120/240 V.
2—100 kva, Whse., 2400—120/55 V.
3— 75 kva, Whse., 2400—240/480 V.
3— 75 kva, Moloney, 4150—240 V.
3—50 kva, Whse., 440—220/110 V.
6—50 kva, G.E., 2400—120/240 V.

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1250 KVA Westg., 3 ph., 60 cy., 480 volts, 1200 RPM, with 15 KW direct connected Exciter. Late modern steel frame & base unit. Complete with **SYNCHRONOUS CONDENSER** control gear.

125 VOLT DC GENERATORS

KW	Make	Speed
200	West.	900
150	Westg.	1200
150	Westg. (3)	900
100	Cr. Wh.	1200
100	E.M.	1200
100	G. E. (2)	900
100	Westg.	1200
100	Westg. (2)	900
75	G. E. (2)	1200
50	Westg. (2)	1150

PLUS 40 additional units ½ to 40 KW

250 VOLT DC GENERATORS

KW	Make	Speed
2000	G. E.	NEW
1150	G. E.	NEW
750	G. E. (2)	NEW
500	G. E.	500
400	G. E.	NEW
250	Cr. Wh.	1200
200	El. Mchy.	900
150	G. E.	1200
125	G. E. (2)	1200
125	E. D.	1750
100	Delco (4)	1150
75	Westg.	900
75	Cr. Wh.	1150
60	N. W.	1150
40	Rel.	1750
40	G. E. 3-Unit	1150
25	G. E.	1200
17	A-C	1750
15	Star	1750
10	G. E.	1150

PLUS 15 additional units ½ to 7½ KW

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10 SPECIALS

1563 KVA 3/60/480 v. GE. TURBO unit "bleeder"

625 KVA Al Chal TURBO unit, non-cond. 3/60/480/240 v.

375 KVA (2) GE 3/60/440 v—Skinner UNI-FLOW units

250 KVA (2) Wqhse 3/60/480/240 v—7 cyl. DIESEL units

187 KVA GE 3/60/440/220 v—Skinner UNI-FLOW unit

125 KVA GE 3/60/440/220 v—Sterling GASOLINE unit

500 HP (3) B&W 160# H4 BOILERS

300 HP (2) Keeler 250# PACKAGE BOILERS

300 (2) B&W 160# H3 BOILERS

250 HP (2) B&W 225# H3 BOILERS

POWER PLANT EQUIPMENT CO.

39 CORTLANDT STREET **NEW YORK, N. Y.**

MOTORS MG SETS

Qty.	HP	Make	Voltage	Speed
12	3000	West.	525/600	600 RPM
26	1500	West.	525/600	600 RPM
32	1500	Al. Ch.	525/600	675 RPM
4	1200	Al. Ch.	525/600	650 RPM
2	900	Elliott	230	300/195 RPM
3	800	West.	525/600/600/900	RPM
1	650	Cr. Wh.	230	475/720 RPM
1	500	West.	230	250/500 RPM
1	400	G.E.	230	180/360 RPM
7	400	Elliott (new)	230	400/800 RPM
1	400	West. (new)	230	375/750 RPM
2	350	Cr. Wh.	230	400/800 RPM
1	200	Cr. Wh.	220	500/750 RPM
1	200	Cr. Wh.	230	375/750 RPM

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100—2000 KW Capacity

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1 complete Fairbanks Morse plant—3—225 HP, 1—150 HP Model 32E14 with 185 and 156 Kva Generators—240-480 volts—3—360 HP Model 32E Fairbanks, 300 Kva Generators.

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96 KVA Fairbanks-Morse Diesel sets Model 32E12, 2 Cyl., 3/60/120/208 Volts, 360 RPM. Complete Plant.

100 KW General Motors Model 3-268A, A.C. & D.C. units. Overhauled.

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1250 HP MOTORS 3/60/2300 V

5—Allis Chalmers type ANW induction motors 1250 HP 3 phase 60 cy 2300 V 1180 RPM Cont. full load 40° C. Couplings attached.

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1—500 KW Crocker Wheeler CCD, 250 volt 720 RPM with 750 KVA Cr. Wh. Syn. Motor 3/60/2300 V. A.C. & D.C. Panels.
1—300 KW Ridgway 250 V. 3/60/2300/1200 rpm
1—300 KW West. 3 wire 125/250 Volt 1200 RPM Generator (1938 year). Can furnish with suitable motor. Advise Requirement.
2—250 KW Burke 125 V. 435 KVA Syn. M.D. 3/60—any voltage
2—180 KW G.E. Frequency Changers 60/120 cycle
1—150 KW G.E. Type MPC—250 Volt 1200 RPM 3/60/2300/200 H.P. Syn. Motor Drive A.C. & D.C. Panels
1—100 KW G.E. RC 17, 125 v. 3/60/220/1200 rpm
1—100 KW Electro Dynamic 200 V. 3/60/220/1200 B. Brg. Sq. Cg. Sep. Excited.
1—100 KW Al. Ch. 250 V. 1200 RPM 150 HP. Syn. Mtr. 2/60 or 3/60 any voltage.
1—100 KW West SK Comp'd 125 V., 150 HP West syn. 3/60/440/1200 rpm.
1—75 KW Burke 250 V. 900 RPM 113 H.P. Burke—Syn. M.D. 2 or 3 ph, any voltage.
2—70 KW Century, 1000 amp, 70 volt, 3/60/220/440
1—62½ KW 125 volt Hertner, 1200 rpm, 100 HP Sq. Cg. 3/60/220
2—50 KW GE 500 Volt DC, 75 HP, 3/60/40/1200 RPM.
1—18 KW Optimus, 3000/1500 amp 6/12 volt
1—17 KW West., 28 v. 60 amp 3/60/220
1—6 KW G.E. 6 v. 100 amp, 3/60/220

DIESEL GENERATOR SETS

2—800 KVA ALCO-Sulzer, 240 D.C. or 3/60 any voltage, 720 rpm
3—625 KVA Ingersoll Rand, 3/60/480/720 rpm
375 KVA GM 8-268 Diesel 3/60/440
300 KW GM 8-268 Diesel 125/250 V. D.C.
187 KVA GM Twin Diesel 3/60/220 New
125 KVA Waukesha Diesel 3/60/220-440
100 KW Buda Diesel 250 V. D.C.
100 KVA Murphy Diesel 3/60/220-440
65 KVA Buffalo Gas 3/60/220
56 KVA Climax Gas 3/60/220
45 KVA Chrysler Diesel 3/60/220
30 KVA LeRoi Gas 3/60/220
25 KVA LeRoi Gas 1/60/120/240
20 KW Hercules Gas 110 volt D.C.
18.75 KVA Hercules Diesel 1/60/120/240

BOILERS

1—25000# Foster Wheeler 250 Lb. W. T. Package Oil & Gas Comb. New
1—50,000# Erie Stoker New 160 psi
1—300 HP Keeler CP 300 lb. Oil
1—250 HP Ames Package type (1948) 150 psi oil fired
1—250 HP B & W 250 lb. 1948
2—200 HP Springfield Sec. Hdr. 400 psi.
1— 25 HP Dowtherm Vaporizer

ELECTRIC MOTORS

QU.	HP	Make	Type	Volts	Speed
1	1500	Al. Ch.	sl. rg.	2300	514
1	1000	G.E.	K	2300	1800
1	1000	West.	CW	2300	450
1	700	West.	CS	2300	1800
1	500	Al. Ch.	Syn.	2300	212
1	500	AC	ARX	2300	1800
1	500	West.	CS	6600/2300	514
1	450	A.C.	ANY	2300	600
1	400	West.	CW	440	514
1	400	G.E.	Syn.	2300	450
3	3500	G.E.	IM	2300	120
1	350	G.E.	MT18	2300	400
2	200	G.E.	KT559	2200	1200
1	200	West.	CW	440	1800
1	200	G.E.	IM	440	600
1	125	West.	Syn. 3 brg.	550	600
2	100	G.E.	KT352	220/440	1200

TURBO GENERATORS

1—2500 KVA West. Cond. New 1936. 3/60/2400—200 psi Surf. Cond.
1—1250 KVA DeLaval Non-Cond. 3/60/2300. New 1940 240 psi 50 lb. B.P.
1—938 KVA GE-Terry Aut. Extr. 3/60/480 150 psi. 20 lb. B.P. Surf. Condenser 1934
1—780 KVA G.E.-Moore 3/60/2300/3600 RPM Non-Cond. 180 PSI 35 lb. B.P. New 1936.
1—187 KVA West. Non-Cond. New 1930 3/60/440 110 psi 10 lb. B.P.
1—94 KVA Worthington Non-Cond. 3/60/220 140 psi 5 lb. B.P.
1—50 KVA 1200 rpm Century generator (New 1949) Dean Hill Non-condensing turbine
1—75 KW G.E. Non-Cond. D.C. 125 volt.

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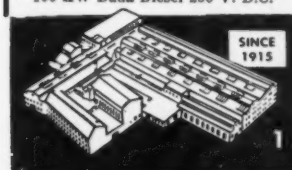
AIR COMPRESSORS

1—1600 cfm IR PRE-2 Syn. Mtr. Dr. 3/60/2300—100 psi.
2—1300 cfm IR-PRE-2 3/60/2300—100 psi
1—1000 CFM Chicago OCE Syn. Mtr. Dr. 175 HP 3/60/2300.
1—978 CFM Sullivan 13x13x8, 45 psi.
1—670 CFM Chicago OCE Syn Mtr. Dr. 3/60/2300
2—660 cfm I R-XRE 3/60/480—100 psi
1—396 CFM Sullivan WL60 125 psi Direct Drive 75 HP 3/60/440
1—215 CFM Penna 3A, 70 psi—V-Belt
1—368 CFM Chi. NSB, 12x10, 100 psi.
1—871 CFM Schramm 7⅛x5x4, 100 psi
1—173 CFM Chicago NSB 100 psi

OISC TRANSFORMERS

Qu.	KVA	Make	Pri. V.	Sec. V.	Phase
3	2000	G.E.	13200	230/460	1
3	1000	GE	13200	2300	1
1	1100	West.	4160	440	3
1	750	O'Brien (New)	13200	480	3
3	667	Al. Ch.	33000	2300	1
3	500	West. Dry	33000	2300	1
3	500	West.	22000	460	1
1	500	Gregory	4160	440	3
3	500	GE	13200	2300	1
3	400	GE	2400	480	1
3	333	West. Dry	2400	480	1
3	333	West. (1945)	33,000	480	1
3	333	Pitts.	33000	2300	1
3	333	G.E.	13800	240/480	1
3	250	Al. Ch.	13,200	115/230	1
2	250	West. Dry	13800	230	1
3	150	West	2300	230/115	1
3	150	Dry	2300/4160	230/460	1
3	100	Dry	2300/4160	230/460	1
3	100	West.	4160	240/480	1
3	85	West.	4160	120/240	1



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M-G SETS! MOTORS!

1—500 KW 240 V. D.C., Whse. M-G Set, 900 RPM, Syn. Drive, 3/60/2200. Ser. 4979926 with magnetic reduced voltage starter.
1—200 KW, 125 V D.C., Type PED, Ser. 576881, E-M Set, 900 RPM, Syn. drive, 3/60/2300 (for 4160).

TURBO-GENERATOR

1—750 KW, Elliott AC Generator, Frame 3232, 3600 RPM, 3/60/180, Elliott Turbine, inlet 200% ga. 112 deg. F superheat. 28" hg. vac. exhaust. Complete with accessories.

SYNCHRONOUS CONDENSER

1—1000 KVA, Allis-Chalmers, 3 phase, 60 cycle, 2300 volts, 600 RPM.

SYNCHRONOUS MOTORS

1—200 HP, F-M, 300 RPM, Type TZO, Frame 5
1—200 HP, E-M, 900 RPM, Type PED, 2300/4160 V
1—150 HP, G.E., 277 RPM Type ATI, 2300 V

SQUIRREL CAGE MOTORS

Amt.	HP.	Speed	Make	Type	Frame
3	250	600	G.E.	KT568(2200V.)	
1	150	1800	Whse.	CS(2200V.)	8718
1	150	1800	A-C	2200V.	
1	150	900	G.E.	I-K(2200V.)	15
1	125	1800	West.	CS	
1	100	1800	Whse.	CS	663C
1	100	1200	Whse.	CS	T52C
1	100	900	G.E.	MT356 Slpr.	
1	100	900	A-C		2300V.

NEW MOTOR STARTERS

1—Size 3 Whse. Combination, circuit breaker, Nema 1, 3/60/440
21—Size 2, G.E. Combination fusible, 60 and 100 amp. 3/60/220. CR7008A42C
88—Size 1 Whse. life line, 3/60/220
7—60 thru 200 HP EC&M, 3/60/2300 Size 10 Magnetic Compensators

GEARMOTORS

1—20 HP, 400 RPM, Westinghouse 1D-XP
1—10 HP, 88 RPM, Master, parallel shaft output
3—10 HP 55 RPM, Whse. Fr. 324, parallel shaft output
1—7½ HP, 11 RPM, Whse. Fr. 284Y, TEFC
1—5 HP, 155 RPM, U.S. Fr. 254, parallel shaft output
18—Cleveland right angle worm gear reducers, rated 5 HP-1150 RPM, 7½ HP-1750 RPM, 6-1 ratio. Series 215. Size 50 RT, Class 1
4—Ratio 10-1, Series 25F—ditto

NEW INGERSOLL-RAND MOTOR PUMPS

Amt.	GPM	HD.	Type	Motor Encl.
2	140	90	2—ORVL—7½	TEFC
2	134	90	2—ORVH-5	XP-1-D
1	1500	35	5—KVL-25	XP-1-D
1	1½ x 1½		AC, 88L	XP-1-D

OISC-TRANSFORMERS—Single Phase

Amt.	KVA.	Make	Type	Volts
9	37½	G.E., Moloney, Whse.		2400-240/480
2	50	Wagner	HEX	4060-1328/2300Y
2	75	Whse.	S	2400/4160-480/240
3	100	West.	S	2400/4160—115/240/480
3	150	Moloney	HE	4000-230/460

PARTIAL LISTINGS—10,000 OTHER MOTORS IN STOCK—SLIPRING—SYNCHRONOUS. NEW MOTORS AT LONG DISCOUNTS.

BENSON-WILIMZIG, INC.

1708 North 8th St. Phone—Garfield 1-4290 St. Louis 6, Missouri

RE-NU-BILT
GUARANTEED

ELECTRIC POWER EQUIPMENT

D. C. MOTORS

Qu.	H.P.	Make	Type	Volts	RPM
1	2200	G. E.	MCF	600	400/500
1	2000	Whse.	Mill	600	230/460
1	1200	G. E.	MCF	600	750/950
1	940	Whse.	QM	250	140/170
1	900	Whse.		250	450/550
1	825	Whse.		250	95/190
1	600	Al. Ch.		250	400/800
1	500	Whse.	CC-216	600	300/900
1	500	G. E.	MCF	600	300/900
2	450	Whse.		550	415
1	400	G. E.	MCF	550	300/1050
1	300	G. E.	MFC	230	360/920
1	200	Whse.	CB-511.3	250	400/800

A. C. MOTORS—3 Ph. 60 Cy.

SLIP RING

Qu.	H.P.	Make	Type	Volts	Speed
1	1500	G. E.	MT-498	2300	360
1	1500	ABB		2300	720
1	1200	G. E.	MT	2300	275
2	1000	A. C.	Mill	2300	240
1	1000	G. E.	MT-452	2200	321
1	500	G. E.	M-574Y	6900	900
1	500	Whse.	CW	550	350
1	450	G. E.	IM	440	720
1	400	Whse.	CW-960A	440	1170
1	400	Whse.	CW	440	514
1	400	Whse.	CW-1218	2200	435
1	350	G. E.	MT-442 Y	2200/4000	253
1	350	G. E.	IM-17A	440/2200	720
1	250	G. E.	MT-424-Y	4000	257
1	250	G. E.	MT-559S	2200	1800
1	250	Al. Ch.		550	600

SQUIRREL CAGE

2	650	G. E.	FT-559BY	440	3570
2	450	Whse.	CS-1420	2300/4150	354
1	300	Whse.	CS	440	1170
1	200	G. E.	IK-17	440	580
3	200	G. E.	KT-557	440	1800
1	150	Whse.	CS-8568	440	880
1	150	Whse.	CS	440	580
1	150/75	G. E.	IK	440	900/450
2	125	Al. Ch.	ARW	2200	1750

SYNCHRONOUS

1	4350	C. W.	3501-SL	13800/6900	514
2	3500	G. E.	TS	2300	257
2	2100	G. E.	ATI	2300	360
2	1750	G. E.	ATI	2300	3600
2	2000	Whse.		2300	120
3	735	G. E.	ATI	2200/12000	600
1	720	G. E.	TS	2300/4600	720
1	500	Ideau	SM	2300/4160	1800
1	500	Whse.		440	900
1	450	Whse.		2200	128.5
1	450	Whse.		2200	450
1	400	G. E.	TS	2200	400

M-G SETS—3 PH. 60 CY.

Qu.	K.W.	Make	RPM	D.C. Volts	A.C. Volts
2	2000/2400	G. E.	450	250/300	2300/4600
2	2000	G. E.	450	600	2300/4600
1	2000	G. E.	500 25cy	660	11000
2	2000	G. E.	514	600	6600/13200
1	1500	G. E.	720	600	6600/13200
1	1500	C. W.	514	30/115	4000/13000
2	1000	Whse.	900	600	4160
3	1000	G. E.	720	600	2300/4600
1	1000	G. E.	900	260	6600
1	1000 (3U)	G. E.	900	250	2200
1	750	Whse.	900	275	4160
1	750	C. W.	514	30/115	2300
1	600	G. E.	720	250	440/2300

TRANSFORMERS

Qu.	KVA	Make	Type	Ph.	Voltages
1	6000	Whse.	OISC	3	3300x26400
1	2500	Whse.	OISC	3	26400/13200x460
3	2000	G. E.	HVDDJ	1	66000/138000
1	1500	G. E.	HT	3	13200x2300
3	1000	G. E.	HVDDJ	1	2400x480
6	1000	Wagner	OI8C	1	13200x460

FREQUENCY CHANGER SETS

Qu.	KW	Make	Freq.	Voltages
1	12500	Whse.	60/25	132x0/13200
1	3000	G. E.	60/25	2300/2300/4000
3	2500	G. E.	25/62.5	2300/2300
1	1000	G. E.	25/58.3	4400/2300
1	500	Al. Ch.	2560	11000/2300

TURBO GENERATORS

Qu.	KW	Make	Desc.
1	4000	G. E.	Condensing 425—750 F. T. T. Surface Condenser 3/60/2300/4000 V Direct conn exciter
1	1500	Whse.	Auto-extraction 190 lbs.—600° F.T.T. 60 lb. extraction 3/60/240 V. Div. conn. Exc.
1	1000	Moore	Auto-Ext. Cond. 175/200# I.S.P. 5/20# G. Ext. Surface Condenser—3/60/2300.
1	1000	G. E.	Non-condensing 175/200 lbs. I.S.P. 5/20 lbs. G.B.P. 480/3/60.
1	750	G. E.	Condensing 265 # I.S.P. 440V. 3 ph. 60 cy.—New—1944
1	750	Whse.	—Non-condensing 1 5r I.S.P. 40# B.P. 750 Kw. 280 V. D.C.

BELYEA COMPANY, INC.
43 Howell St., Jersey City 6, N. J.

FOR SALE

(2) EX-LIBERTY SHIP BOILERS
24,000 pounds per hour—4890 sq. ft.—225 pounds working pressure. Made by Combustion Engineering Co. Located West Coast.

(3) SCOTCH MARINE BOILERS
225 pounds working pressure. Approximately 17,500 pounds each, per hour.

(4) 300 KW G.M. 8-268A DIESEL GEN.
G.M. diesel generator sets—120/240 volts DC—1200 RPM—1250 amps.—8 cyl. 6½x7—with switchgear.

NEW 60 KW CUMMINS DIESEL GEN. SET
60 KW—120 volts DC

(2) 100 KW GM 3-268A 440/60/3 AC generator sets.

(1) 100 KW LORIMER 440/60/3 AC generator set.

(1) 100 KW FAIRBANKS-MORSE opposed 440/60/3 AC generator set.

75 KW WAUKESHA DIESEL GEN.
Heavy duty—totally enclosed—with built-in switchgear. 75 KW—230 volts DC. 6• cyl. Waukesha diesel, 160 HP, 1200 RPM. Radiator cooled.

(6) 300 KW TURBO GENERATOR SETS
120/240 volts DC—Joshua-Hendy turbine—250 lb. W.P. condensing. Suitable for pressures to 440 lbs. at 740°TT. Geared to 1200 RPM. 300 KW Westinghouse 120/240 volt 1250 amp. stabilized shunt generator. With switchgear. Built 1945. Excellent condition.

(1) SUPERIOR HEAVY DUTY DIESEL
510 HP at 360 RPM—5 cylinder—14½x8—type ZDSB—non-reversing—vertical—4 cycle—cold starting—mechanical injection. Engine totally enclosed. For heavy duty pumping, dredge service, power generation, textile & saw mills, etc. Excellent condition. Immediate delivery.

ELECTRIC WINCHES
50 HP—230 volts DC—built in controls—5 ton and 10 ton.

THE BOSTON METALS CO.
313 E. Baltimore Street
Baltimore 2, Md.
Curtis 7-5050

BOILERS

4—1200 H.P. B&W Sectional Steel Header Cross Drum Boilers, 225# design pressure, Mfg. in 1924. Code. All usual accessories. Lower rows retubed in 1950. Located in N. Y. State.

2—824 HP Sterling Boilers, 1930, active certificate for 300# W.P. chain grate stokers, ELESCO superheaters, all auxiliaries, Austin, Minn.

3—600 HP, B. and W. longitudinal drum, sectional header boilers, A.S.M.E. 225# steel headers. Located N. Y. State.

2—509 HP, B. and W. Boilers, 1916, retubed 1952 209# W. P. Lawrence, Mass.

1—490# Walsh-Wicener Cross Drum, Sectional Headers, 4" tubes, 1927, 450# W. P. all auxiliaries. West Point, Virginia.

1—400 HP Keeler C. P. Boiler, 1942, 160# W. P. new tubes and refractory, TODD mechanical oil burner and pump set. Overhauled, dismantled. Ready to ship. N. Y.

Complete plant consisting of:
2—20,000# pr. hr., 160# W. P., 1942, B. and W. steam generators, deaerating heater, all boiler auxiliaries. A complete plant. San Fernandino, Florida.

1—310 HP Keeler C. P. Boiler, 160# W. P. 1942, pressure parts ship in one piece. Lake City, Florida.

1—250 H.P. B.&W. Sectional Steel Header Boiler, 250# W. P. All usual accessories and trim, mfg. in 1924. Location—Florida.

WARNER J. SHERB, INC.
342 Madison Avenue, New York, N.Y.
Telephone MUrray Hill 2-9098

2—200 H.P. Herringlone reduction gears, 6 to 1 and 4.5 to 1 ratio.
1—200 k.w. 500 Y. mtr. gen. set and controls.
1—235 K.V.A. Cr.-Wh. Syn mtr. and starter.
3—10x10 Frick ammonia Compressors
1—46"x14' Ammonia Condenser.
600—11 x 22 x 51 Ice cans.
2—34" x 14' single pass Brine Coolers.
1—24" x 17'6" Ammonia Receiver.
1—3½ ton Euclid Electric Crane.
DAVID BERNARD, 72 Broadway, N. Irwin, Penna.

FOR SALE WATER PUMPS
Purchased in 1944 — Never Used

1. DeLaval Steam Turbine pump (centrifugal) serial #244389, 1770 rpm, Capacity 2000 gpm, Head 290 feet.
Driven by Westinghouse induction Motor serial #1443, 200 H.P., 2200 volt, 3 phase—60 cycle, 1775 R.P.M.

2. DeLaval Steam Turbine Pump (centrifugal) serial #244388, 1740 rpm, Cacapity 1200 gpm, Head 325 feet.
Driven by Westinghouse Induction Motor serial #5243, 125 hp, 2200 volt—3 phase—60 cycle, 1740 R.P.M.

Further particulars on request

BRUNSWICK & TOPSHAM WATER DISTRICT
9 Town Hall Pl., Brunswick, Maine

FOR SALE

2—255 HP, Type S Ingersoll-Rand Oil Engines, direct connected to 219 KVA, 2400 volts, 3-phase generators

1—275 HP PVG Ingersoll-Rand Gas Engine direct connected to 237 KVA, 440 volt, 3-phase Westinghouse generator.

Units complete with switchboard panels, instruments and necessary accessories. Located: Chatham (Medina Co.), Ohio.

DYMO OIL CORPORATION
PO Drawer 550 Olean, New York

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Diesels	**Rotary Converters**	**Synch. & Ind. Motors**
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Transformers	**Frequency Changers**	**Feeder Voltage Regulators**

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- D.C. MOTORS
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- GENERATORS
- TRANSFORMERS
- CONTROLS
- COMPRESSORS
- HOISTS • PUMPS
- SWITCHBOARDS

If you don't find what you need wire, write or phone for complete stock list.

SQUIRREL CAGE MOTORS

3 Phase, 60 Cycle, 220 or 440 Volts (*2300 volts or higher)

H.P.	Make	Type	Speed
1500	*Westg.	CS	1200
800	*Westg.	CS-1485	1800
700	*Westg.	CS	1200
500	*Al-Ch.	6316-SW	1800
500	G. E.	KT-424	450
400	G. E.	KF-559	3600
400	G. E.	KT-424	360
300	Al-Ch.	AN	1750
300	*G. E.	K-6344Y	1200
300	G. E.	K-6353 TEFC	720
250	*L-Allis	OEX 148	720
250	G. E.	IK-17A	600
200	*G. E.	FT-549Y	3600
200	*G. E.	IK-13B	1800
200	*Al-Ch.	AN	720
200	Al-Ch.	ARWWT	585
200	*Westg.	CS	600
200	G. E.	IK-17	600
200	G. E.	K-6352	514
150	Al-Ch.	AR	3600
150	G. E.	IE-13A	1800
150	G. E.	IE 13B	1200
150	*Westg.	CS-812 S TEFC	1200
150	Westg.	CS-854	900
150	Westg.	CS-876C TEFC	900
150	G. E.	IK-16	600
150	*Westg.	CS	600
125	*Al-Ch.	AR	1800
125	Al-Ch.	AR-226 CS	1800
125	*Reliance	AA 6085	900
125	Al-Ch.	AN	900
100	L-Allis	1148-Ex.Pr.	3600
100	Westg.	CS 505 S TEFC	3600
100	Westg.	CS-6078-TEFC	3600
100	*Westg.	CS	1800
100	*G. E.	FT-542Z	1800
100	G. E.	FT RP-543	1800
100	G. E.	K-5048	1800
100	G. E.	KT-543	1800
100	G. E.	IK	1200
100	Al-Ch.	ANW-23D	1200
100	*Westg.	CS (Vert)	1200
100	U. S.	CFU (Vert)	1200

MOTOR-GENERATOR SETS

1000(3u)	Westg.	11000	137/275
500	Westg.	2300	137/275
500	Westg.	2300	275
450(3u)	G. E.	2300	125/250
400	A. C.	2300	120/240
300	G. E.	2300	250
200	G. E.	2300	250
200	Westg.	4160	250
200	Ridgeway	2300	250
170	G. E.	440	125
150	G. E.	2300	125/250
150	G. E.	4000	250
150	A. C.	2300	275
150	G. E.	440	275
100	Westg.	440	125
100	Elec. Mach.	440	125
100	Ridgeway	2200	275
100	G. E.	240	230
100	G. E.	440	125
100	G. E.	440	60
75	G. E.	440	125
60	Westg.	2300	125
60	A. C.	2300	125
50	Reliance	440	250
50	Westg.	240	125
40	G. E.	440	125
40	G. E.	440	250
35	Westg.	2300	150
30	G. E.	440	125
30	Westg.	2200	125
30	Cr.-Wh.	440	250
20	Bogue-GE	550	250
20	Bogue-G.E.	220/440	250
15	Westg.	220/440	250

SPECIAL
GEAR MOTORS

2—30 H.P. Westinghouse, Type CS-404, 3/60/220-440/TEFC, 1800 rpm with Falk Class 2-9.394 ratio reducer —190 rpm output.

SLIP RING MOTORS

3 phase, 60 cycle, 220 or 440 volts (*2300 volts, or higher)

H.P.	Make	Type	Speed
2000	*G. E.	MT-12	600
1500	*G. E.	MT-30	240
1250	*Westg.	CW	600
1000	*Westg.	CW	250
800	Al-Ch.	ANY	600
700	*Al-Ch.	ANY	720
600	*G. E.	MT-422	600
500	*Al-Ch.	ANY	600
500	Westg.	CW	350
400	Al-Ch.	3-brg.	450
400	*G. E.	MT-412	450
300	*G. E.	IE-15A	1800
300	*G. E.	MT-410	450
250	Westg.	HF-15H	600
200	*Westg.	CW	1200
200	G. E.	IK-15B	900
200	G. E.	IM	600
150	Cr. Wh.	50-B	1800
150	G. E.	MT-549	1800
150	Westg.	CW-772C	1200
125	G. E.	IM-15A	600
100	G. E	IT-13A	1800
100	Al-Ch.	ANY	900
100	G. E.	IM	600
100	G. E	IM	450
75	Nor. Wes.	HW-50	1800
75	G. E.	MT-347	1200
75	G. E.	IM	1200
75	Al-Ch.	ARY-223C	1165
75	G. E.	MT-356	900
75	Al-Ch.	ANY	900
75	Westg.	CW-766A	900
75	G. E.	IM	600
75	Al-Ch.	ARY	720
75	Westg.	CI-756A	600
60	*Westg.	CW-762A	900
50	*Al-Ch.	ARY-220-B8	1800
50	Gen. Elec.	IM	1800
50	*Al-Ch.	ARY	1200
50	Westg.	CW-636A	1200
50	Westg.	CW-658A	900
50	G. E.	MT-356	900
50	G. E.	MT-346	720

CHICAGO Electric Co. 1320 WEST CERMAK ROAD, CHICAGO 8, ILL.

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We carry a large stock of rebuilt and guaranteed transformers, and invite your inquiries.
Custom-built transformers and coils manufactured to your specifications.
Expert Repair Service—all makes and sizes of transformers rewound, repaired and redesigned.

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5331 Hetzel St. Cincinnati 27, Ohio
40 Years' Dependable Service

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AMERICAN AIR OF JERSEY
AIR FOR SALE OR RENT
SINCE 1902
GAS • DIESEL • STEAM • ELECTRIC

55 CFM Lindsay (GAS) Portable
60 CFM Worthington—CPT—Portable
60 CFM LeRoy (GAS) Portable—Skids
89 CFM 6 x 7 Worthington HB-15HP—Elec.
105 CFM Worthington—IR—CPT—Portable
160 CFM IR—Worthington—Portable
165 CFM Smith 110SR Semi-Portable—25 HP
167 CFM 10 x 5 Ingersoll Vacuum Pump—7½ HP
170 CFM Davey Semi-Portable—25 HP
195 CFM 8-9 x 9 Chicago T-S Steam
210 CFM Worthington (GAS or Diesel) Portable
211 CFM 9 x 9 Chicago T-B, 30-40 HP—Elec.
211 CFM 9 x 9 Ingersoll ES, 30-40 HP—Elec.
279 CFM 10 x 11 American 50 HP—Elec.
284 CFM Worthington Semi-Portable, 50 HP
315 CFM Worthington (GAS or DIESEL) Portable
388 CFM Worthington Semi-Portable, 75 HP
450 CFM 13/9 x 10 Chicago O-CB Duplex, 75 HP Elec.
500 CFM Worthington (DIESEL) Portable
552 CFM 13/9 x 10 Chicago O-CB Duplex, 100 HP Elec.
600 CFM Worthington (DIESEL) Portable

VACUUM PUMPS

720 CFM 18 x 7 Worthington HBV Vacuum Pump 25 HP
1184 CFM 22 x 9 Chicago T-VB Vacuum Pump 40 HP
1633 CFM 24 x 11 Chicago T-VB Vacuum Pump 60 HP

QUALITY REBUILTS BY AMERICAN
5 CFM to 5000 CFM—5 Lbs to 3000 Lbs

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COOPER CORLIS ENGINE

13 x 30 with G.E. two phase generator 125 KVA 10 KW exciter D.C.

HESSLER LAUNDRY
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STEAM TURBINES
And Gear Reduction Units

1—Westinghouse 150 H.P. Steam Turbine and Gear Reduction Unit.
1—Westinghouse 100 H.P. Steam Turbine and Gear Reduction Unit.

These units are in excellent condition and priced reasonably. They are designed for inlet steam pressures of 105 and 90 lbs. respectively and 15 lb. back pressure. They can be used efficiently with higher initial steam pressure.

FS-2342, POWER
330 W. 42nd St., New York 36, N. Y.

DIESEL & TURBINE GENERATORS

300 KW New Baldwin DeLaverne 6 cyl. Mod. VO 400 RPM w/DC 120 240 V West. Gen.
100 KW GM 6 cyl. Mod. 6228 1200 RPM w/AC 3/60/440 V G.E. Gen.
80 KW Cat. 6 cyl. Mod. D3800 900 RPM w/AC 3/120-208 V Louis Allis Gen.
40 KW New Buda 4 cyl. Mod. 691 1200 RPM w/DC 120 V Burke Gen.
30 KW Int. Harv. 4 cyl. Mod. UD14 w/AC 120-208 V Century Gen.
150 KW New West. DC 240 V 1200 RPM 225# Pres./3260 RPM Turbine thru reduction gear
200 KW Al. Chal. AC/3/60/240 V/3600 RPM driven by DeLaval dir. connected turbine
500 KW West DC 120-240 V 1200 RPM

ALBERT HELLER CO.
210 Snediker Ave., Brooklyn 7, N. Y.
HYacinth 5-0800

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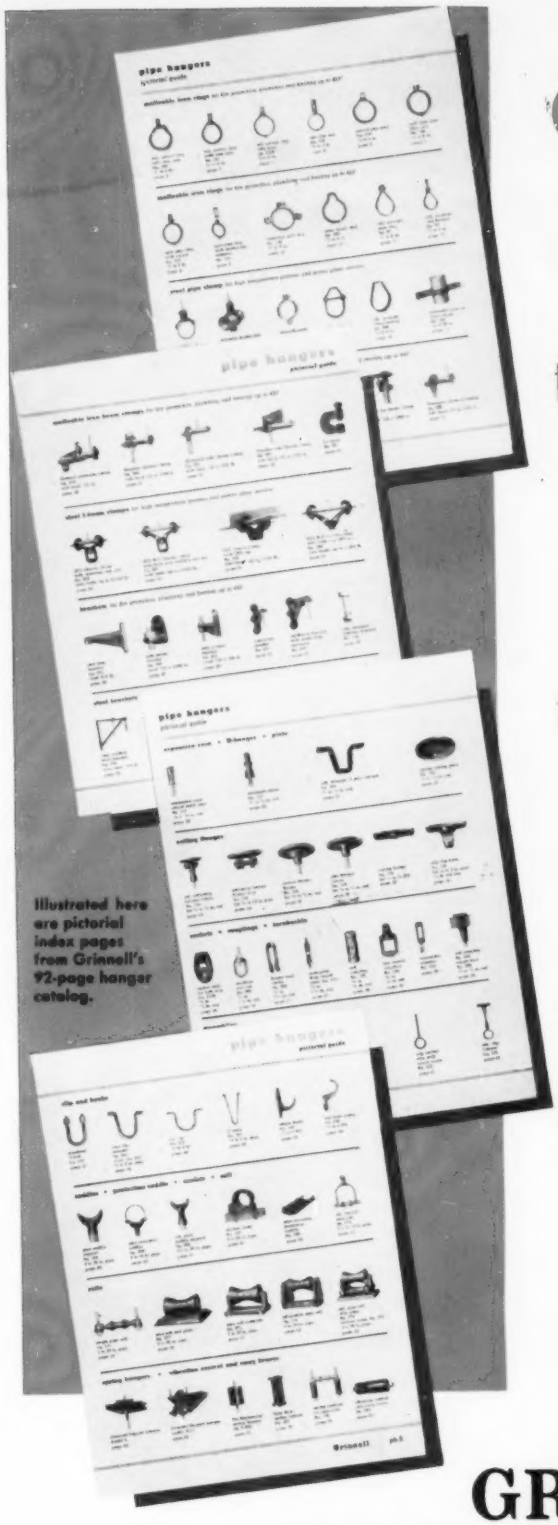

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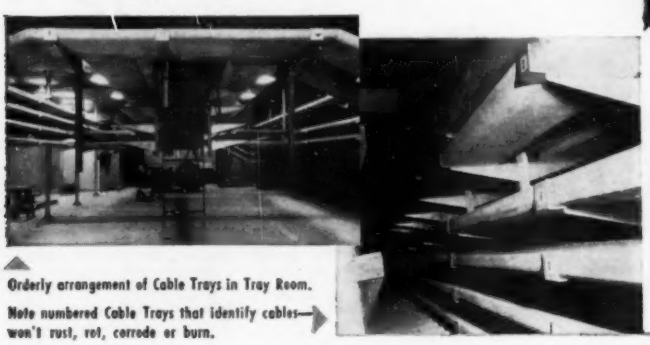

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